PORTLAND HARBOR RI/FS

APPENDIX L

CWA SECTION 404(B)(1) EVALUATION

June 2016

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L1.0 INTRODUCTION

The proposed remedial alternatives described in FS Section 3 being evaluated under the CERCLA must comply with ARARs, including the CWA Section 404(b)(1), 40 CFR Part 230. EPA has issued guidance on how cleanup actions in waters of the United States should be considered in remedy decision-making (EPA 1994). The purpose of this preliminary Section 404(b)(1) analysis is to support EPA's evaluation of the substantive compliance of the remedial alternatives, including the disposal options Dredged DMM scenarios 1 and 2 with this ARAR.

The 404(b)(1) analysis first determines whether an activity is water dependent. If it is, potential impacts to the aquatic environment for each alternative are identified and evaluated. The proposed action will be selected in accordance with CERCLA, the NCP's remedial action alternatives evaluation, through the nine criteria. Thus, the NCP alternatives evaluation and analysis is used to determine practicability of alternatives, which is described in FS Sections 3 and 4. This 404(b)(1) analysis document focuses on evaluating the impacts to the aquatic environment from the alternatives identified in the FS, including the impacts to the aquatic environment from the disposal options. Since upland disposal is not water dependent, the upland disposal option needs to be evaluated.

Section 404(b)(1) of the CWA requires that remedial alternatives be designed to avoid or minimize adverse impacts to aquatic resources and waters of the United States. Compensatory mitigation is considered only after other appropriate and practical options have been considered to avoid, minimize, or otherwise rectify unavoidable, adverse impacts on the aquatic environment, including impacts on aquatic species. Section L3 describes the existing environment and potential impacts of the No Action alternative and the proposed remedial alternatives, Section L4 summarizes issues related to the evaluation and testing of discharge material. Measures in the mitigation sequence to avoid, minimize, and compensate for potential impacts, are summarized in Section L5. Many of these measures are described in greater detail in the Preliminary Programmatic Biological Assessment (BA). The Preliminary BA is an evolving document that will be further defined during the remedy selection process and in the remedial design. The measures identified and described in the Preliminary BA may be subject to change. Section L8 provides the determinations of the 404(b)(1) analysis.

L1.1 PROJECT BACKGROUND

Portland Harbor was formally listed as a Superfund site in December 2000. EPA is the lead agency for this Site.

Several investigations of the Site have been conducted by the LWG for the Portland Harbor Remedial Investigation (RI) and FS (EPA 2001, 2003, 2006). As part of the RI, baseline ecological and human health risk assessments were completed (Windward 2011; Kennedy/Jenks Consultants [Kennedy/Jenks] 2013, respectively).

The Site extends from RM 1.9 to 11.8 as shown in Figure 1-1 of the FS. Some river bank areas with known contamination are also included as part of the Site (Figure 3.4-14a-h of the FS).

While the harbor area is extensively industrialized, it occurs within a region characterized by commercial, residential, recreational, and agricultural uses. Land uses along the lower Willamette River in the harbor include marine terminals, manufacturing, and other commercial operations as well as public facilities, parks, and open spaces. The terms Site, harbor-wide, and site-wide used in this evaluation generally refer to the river sediments, pore water, and surface water within this reach of the lower Willamette River and not to the upland portions of the Portland Harbor Superfund Site.

This 404(b)(1) evaluation relies upon the information found in the RI/FS and the Programmatic Biological Assessment, which assesses potential effects on threatened and endangered species and critical habitat under the ESA. These documents provide much greater detail on the implementation of remedial technologies and potential effects of specific technologies on listed species and critical habitat.

While this 404(b)(1) evaluation covers the full extent of remedial actions described in the FS, implementation of the selected remedial action will go through remedial design, which will determine the actual footprint of remediation areas and through which more details about how the remediation will proceed will be determined. Final and more specific avoidance and minimization measures and compensatory mitigation plans will be developed during the remedial design phase for the remedial action.

L1.2 PROJECT PURPOSE AND NEED

The basic purpose of the proposed remedial alternatives is to remove and remediate contaminated sediments within the Site, which is located within waters of the United States. The overall purpose is to reduce potential risks from contaminated sediments and surface water to acceptable levels consistent with the RAOs established for the Site.

The need to take action is based on the potential for unacceptable risks to human and ecological receptors from exposure to COCs in sediments, groundwater, surface water, fish tissue and river banks in the Portland Harbor Superfund Site, as described in detail in the RI and further summarized in the FS. Most of the contamination at the Site is associated with known or suspected historical sources and practices. Ongoing sources of contamination include contaminated groundwater plumes, river bank soils, storm water and upstream surface water discharges. COCs in sediments at the Site include PCBs, dioxins/furans, pesticides, DDx, chlordane, aldrin, dieldrin, PAHs, and metals. Persistent contaminants (particularly PCBs and dioxin/furans) in sediments and surface water bioaccumulate in progressively higher trophic levels within the food chain.

The baseline human health risk assessment (BHHRA), conducted as part of the RI, presents an analysis of the potential risks associated with both current and potential future human exposures to COCs at the Site. Potential exposure to contaminants found in environmental media, including biota, was evaluated for various occupational and recreational uses of the river, as well as consumption of fish and shellfish. The Site poses unacceptable risk to human and ecological receptors.

An evaluation of risks to aquatic and aquatic-dependent species within the Site is presented in the BERA. The most ecologically significant COCs are PCBs, PAHs, dioxins and furans (as 2,3,7,8 TCDD eq), and DDT and its metabolites. Total PAHs, PCBs, and DDx have the greatest areal extent of unacceptable ecological risk.

L1.3 OBJECTIVES

RAOs were developed for the Site in the FS. RAOs consist of media-specific goals for protecting human health and the environment. RAOs provide a general description of what the cleanup is expected to accomplish and help to focus alternative development and evaluation. The RAOs for the Site can be found in FS Section 2.

L1.4 WATER DEPENDENCY DETERMINATION

The proposed remedial alternatives address contaminated sediment, surface water, pore water and river banks that are located within or adjacent to jurisdictional waters. Therefore, the proposed remedial alternatives are water-dependent activities (40 CFR § 230.10), and upland-based remedial activities would not address the purpose and need of the project. There are two dredged material management scenarios which include a Confined Disposal Facility and upland commercial landfills for disposal of materials removed from the Site. Therefore, disposal options are not water dependent, so a 404(b)(1) analysis must be conducted to evaluate in-water disposal in the CDF compared to disposal in an upland facility, as described in Section 2.

L2.0 DESCRIPTION OF THE REMEDIAL ALTERNATIVES

L2.1 PROJECT LOCATION

For purposes of FS evaluation, the Site is broken up into four distinct regions: the navigation channel and FMD region, the intermediate region, the shallow region, and the river bank region. These designations were used to support the assignment of remedial technologies and the evaluation of remedial alternatives in the FS. The navigation channel and the FMD region encompasses the federally authorized navigation channel and areas near and around docks based on information regarding vessel activity, dock configuration, and future site uses where maintenance dredging is likely to occur**.** FMD locations were developed from estimates of likely future navigation depth requirements and potential future maintenance dredging depths near and around docks. A description of how the FMD locations were determined is provided in Appendix C. The intermediate region is defined as outside the horizontal limits of the navigation channel and FMD region to the bathymetric elevation of 4 feet NAVD88. The shallow region is defined as shoreward of the bathymetric elevation of 4 feet NAVD88. The river bank region refers to contaminated river banks identified in Section 1.2.3.5 of the FS. Alternatives also encompass upland areas for temporary storage of dredged material and debris, and dewatering activities, as well as transloading facilities and permanent upland disposal sites.

L2.2 REMEDIAL ALTERNATIVES

The proposed remedial alternatives were developed and are presented in the FS Section 3. A summary of the remedial alternatives evaluated in the FS is presented in Table 3.9-2 of the FS. With the exception No Action Alternative, Alternatives B-I all use a combination of dredging, capping, in-situ treatment, ex-situ treatment, enhancement natural attenuation (ENR), monitored natural attenuation (MNR) and institutional controls to address the risks. All alternatives utilize DMM Scenario 2, only Alternatives E-I DMM Scenario 1 in addition to upland disposal. These technologies and disposal options are further discussed in detail in FS Sections 2 and 3.

L2.2.1 Monitored Natural Recovery

Natural recovery typically relies on ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment. These processes may include physical (burial and sedimentation or dispersion and mixing), biological (biodegradation), and chemical (sorption and oxidation) mechanisms that act together to reduce the risk posed by the contaminants. However, not all natural processes result in risk reduction; some may increase or shift risk to other locations or receptors. MNR includes monitoring of the water column, sediment, and biota tissues to assess whether these natural processes continue to occur and at what rate they may be reducing contaminant concentrations in surface sediment. MNR does not include construction measures.

L2.2.2 Enhanced Natural Recovery

ENR refers to enhancement or acceleration of natural recovery processes to reduce risks within an acceptable time frame. As with MNR, ENR entails monitoring to assess whether natural processes continue to occur and at what rate they may be reducing contaminant concentrations in surface sediment. Areas that are stable (exhibit low shear stress) and are recovering naturally are candidates for ENR. ENR would be applicable to broad areas of the Site with lower levels of contamination, net sedimentation, and where significant erosion is not a concern.

A 12-inch layer of clean material (sand) would be used to accelerate recovery through several processes, including dilution of contaminant concentrations in sediment and decreasing exposure of organisms to the contaminated sediment. The grain size and organic carbon content of the clean sediment to be used for a thin-layer cover would be selected to approximate common substrates found in the area and provide suitable habitat for benthic organisms native to the lower Willamette River. Clean material can be placed in a uniform thin layer over the contaminated area or it can be placed in berms or windrows, allowing natural sediment transport processes to distribute the clean sediment to the desired areas.

L2.2.3 Containment

Containment entails the physical isolation (sequestration) or immobilization of contaminated sediment by an engineered cap, thereby limiting potential exposure to, and mobility of, contaminants under the cap. Caps are designed to reduce potentially unacceptable risks through: (1) physical isolation of the contaminated sediment or soil to reduce exposure due to direct contact and to reduce the ability of burrowing organisms to move contaminants to the surface, (2) stabilization and erosion protection to reduce re-suspension or erosion and transport to other sites, and/or (3) chemical isolation of contaminated media to reduce exposure from contaminants transported into the sediment pore water and water column.

Caps are generally constructed of granular material, such as suitable fine-grained sediment, sand, or gravel, but can have more complex designs. Engineered sand caps, with and without stone armor, were selected as the representative process option for alternatives involving sediment containment. Caps would be designed with different layers (including “reactive” capping layers that provide treatment) to serve these primary functions, or in some cases, a single layer may serve multiple functions. Reactive caps were considered for areas where there are groundwater plumes, contaminants that have higher water solubility in areas with significant groundwater advection (the process by which contaminants are transported by flowing groundwater), or where thinner caps are needed in order to minimize any potential change in flood elevations. Specific cap types are described in FS Section 3.

L2.2.4 In-Situ Treatment

In-situ treatment of sediments refers to chemical, physical, or biological techniques for reducing contaminant concentrations, toxicity, bioavailability, or mobility while leaving the contaminated sediment in place. While capping is focused on physical isolation of contaminants, in-situ treatment is used in areas where it is possible to enhance the degradation or absorption of contaminants in addition to isolation.

In-situ treatment likely would entail sequestration by addition of an amendment, such as activated carbon, to the sediments, which modifies the sorption capacity of non-polar organics and certain metals such as mercury. Amendments can be engineered to facilitate placement in aquatic environments by using an aggregate core (such as gravel) that acts as a weighting component and resists re-suspension so that the mixture is reliably delivered to the sediment bed where it breaks down slowly and mixes into sediment by bioturbation.

The FS assumed that in-situ treatment will be accomplished through the placement of a 12–inch layer consisting of approximately 50 percent sand and 50 percent AquaGate with a powdered activated carbon content of 10 percent mixed with sand to achieve an activated carbon content of 5 percent. Site-specific treatability studies may be required during remedial design to determine the effectiveness of the treatment technology in the environment of the Site and develop specific design characteristics such as the activated carbon application rate.

L2.2.5 Sediment/Soil Removal

Removal of sediments can be accomplished either while submerged (dredging) or after water has been diverted or drained (excavation). Both methods typically necessitate transporting the sediment to an offloading facility for dewatering followed by transport to a Subtitle D or Subtitle C/TSCA landfill.

The FS assumed that sediments would be removed using mechanical dredging techniques. Environmental/closed buckets and fixed arm dredges are the preferred method for dredging. However, cable-operated dredges may be required in certain conditions such as where water depths exceed 40 feet. In addition, traditional clamshell buckets may be required in certain areas such as where there is significant rip rap or debris. The specific method for sediment removal will be determined during remedial design.

Following dredging, a 12-inch sand layer would be placed over the leave surface to cover the exposed surface and isolate any dredge residuals and remaining contaminated sediment. In shallow areas, this would be followed by placement of beach mix, consisting of rounded gravel typically 2.5 inches or less.

Land-based excavators are assumed to be used for removal of contaminated river bank materials or near-shore sediments in locations above the water level. This would limit offsite transport of disturbed river bank materials by the river. Removal of river bank material is assumed to be conducted in the late summer and early fall when river stage is low.

L2.2.6 Disposal

Disposal refers to the placement of dredged or excavated material and process wastes into a temporary or permanent structure, site, or facility. Disposal of dredged or excavated material is not a water dependent use. The goal of disposal is generally to manage sediment and/or residual wastes to prevent contaminants associated with them from impacting human health and the environment.

Disposal of removed media can either be within an upland landfill disposal facility, such as operating commercial landfills, or within an in-water disposal facility specifically engineered for the sediment remediation such as in a CDF. Use of a CAD facility was screened out (see FS Section 2, Table 2.4-2 and Table 2.4-3).

Landfill disposal options considered in the FS include disposal in a RCRA Subtitle D landfill and RCRA Subtitle C or TSCA landfills. Off-site disposal locations retained in the FS (Section 3) include several commercial landfills: Roosevelt Regional Landfill (Subtitle D), and Chemical Waste Management of the Northwest (Chem Waste) Landfill (Subtitle C; accepts RCRA waste).

The sediment and soil disposal decision considerations described in Sections 2 and 3 of the FS are used to guide the process to determine appropriate disposal options for dredged material. The considerations that determine what type of facility can accept dredged or excavated contaminated sediments and river bank soils are complex and include factors such as timing of the work, location within the site, regulatory requirements, and facility acceptance requirements. There are significant restrictions on placement of dredged or excavated materials for placement in a CDF under DMM Scenario 1 in the form of Portland Harbor-specific CDF performance standards as presented in Table 3.3-8 and Section 3.4.9.2 of the FS.

The performance criteria would significantly limit the ability of PTW (which includes NAPL/NRC and highly toxic wastes) to be disposed in the CDF. For purposes of the FS, there is sufficient volume of non-PTW contaminated sediment for alternatives that evaluate DMM Scenario 1 to assume the CDF receives this material in lieu of PTW, which would be transported off-site for disposal. Should DMM 1 scenario be selected for disposal of dredged and excavated materials in the ROD, the ultimate disposal location of the material will be made during the remedial design, based on sampling.

L2.2.6.1 Upland (Off-site) Disposal

Dredged sediments meeting certain criteria would be disposed of at upland landfill disposal facilities. Prior to transport, sediments would be dewatered, and the wastewater would be treated.

A wastewater treatment plant may be included as part of the on-site management of dredged material. An on-site wastewater treatment plant to manage wastewater for a facility handling sediment from the Portland Harbor Site may include coagulation, clarification, multi-stage filtration, and granular activated carbon adsorption with provision for metals removal, if necessary. The primary difference in the wastewater treatment plant for a hydraulic dredging operation as compared to a mechanical dredging operation would be the volume of wastewater to be treated. As hydraulic dredging results in a larger volume of sediment-water slurry to be managed, a hydraulic dredging wastewater treatment plant would require a larger footprint.

Transportation

Transportation is a necessary component of removal of contaminated sediments from the Portland Harbor Site. The transportation method would be based upon the compatibility of that transportation method to the other process options. The most likely transportation methods are truck, rail, and barge, and/or a combination of these. They are briefly discussed below.

Truck Transport

Truck transportation includes the transport of dewatered dredged material over public roadways using dump trucks, roll-off boxes, or trailers.

Rail Transport

Rail transportation includes the transport of dewatered dredged material via railroad tracks using gondolas or containers. Rail transport is desirable where sediment is shipped over long distances, for example, to out-of-state treatment or disposal facilities. Rail transport may require the construction of a rail spur from a sediment handling facility to a main rail line.

Barge Transport

Barge transportation includes the transport of dredged solids directly to a processing (dewatering) or onsite disposal (CDF) facility or the transport of dewatered dredged material to a transloading facility for transport to an upland disposal facility. Barge transport likely would be used for short distances such as from the dredging location to the dredged material handling facility. In addition, barge transport may be considered for longer distances if dredged material is hauled to treatment or disposal locations that have the ability to accept barge-loaded dredged material. Sediment would be dredged from areas within the Site, loaded onto barges, taken to a transloading facility where it would be prepared for upland transportation, and transferred to rail or truck, and then transported to the landfill for disposal. Potential upland disposal facilities are shown in **Figure L2-1**.

Transloading of Sediments and Debris

Transloading of sediments and debris will be conducted at an upland offload facility in the Lower Columbia River, likely upstream of the Willamette River confluence. Improvements at the offload facility may include berth improvements, fencing, pavement improvements, storm water management berms and other storm water management, watertight transload box installation, drying agent storage, lined containment areas if storage is required, a truck lining station, a truck covering station, a wheel wash, and a dry decontamination station.

Any new impervious surface created as part of the proposed action will comply with NMFS stormwater treatment and detention requirements (NMFS 2014).

L2.2.6.2 Confined Disposal Facility (CDF)

Under DMM Scenario 1 (for Alternatives E through I), dredged material would be disposed of within a CDF, an in-water disposal facility specifically engineered for sediment remediation. As described in the FS, construction of a CDF was considered in Slip 1 of the Port of Portland's Terminal 4, Swan Island Lagoon or offshore of the Arkema site (**Figure L2-2**). All three potential CDF locations were evaluated in the FS. The Terminal 4 CDF location was retained as a representative option in the FS.

Based the 60 percent design report (Anchor-QEA 2011), the CDF at Terminal 4 could contain 670,000 cubic yards of dredged contaminated sediments, not including an additional 200,000 cubic yards of contaminated sediments capacity that may be gained by consolidation settlement of the placed material as the facility is filled. The volumetric capacity of the CDF relative to the estimated volume of sediment to be dredged from the Site and acceptable for placement is a factor in determining the viability of constructing a CDF. Approximately 150 percent of the 670,000 cubic yard volume capacity of the CDF, or approximately 1,005,000 cubic yards, was assumed in the FS to be dredged from the Site to ensure sufficient quantity of material to justify the CDF's construction. Alternatives B through D would not meet the 1,005,000 cubic yards of sediment threshold to justify construction of a CDF.

A CDF at Terminal 4 would fill approximately 14 acres of aquatic habitat (Anchor QEA 2011). Construction would entail demolition of overwater structures and pilings and construction of the containment berm at the mouth of Slip 1 (including dredging a 5- to 10-foot-deep "key" beneath the proposed containment berm location at approximately -40 feet National Geodetic Vertical Datum [NGVD]). This sediment would be removed from its current location and placed at the head of Slip 1 prior to containment berm construction.

The CDF berm would be constructed at a 2:1 side slope, with the exception of a more gently sloped bench (20 percent or 5:1) on the outside face of the berm (**Figure L2-3**). The gently sloped bench on the outside face of the berm was incorporated into the design to reduce the net loss of shallow water habitat in Slip 1 (Anchor QEA 2011). In this way, there would be an improvement in the slope and shoreline conditions along the face of the berm compared to the existing steep-sloped shoreline. This would reduce some of the loss of shallow water habitat important for aquatic species.

Once construction of the CDF berm is complete, the CDF would be fully enclosed from the river, and placement of sediments into the CDF would not be considered in-water work.

Construction of the CDF berm would include a weir and outfall structure that would be used to drain water from the CDF as it is being filled with sediment. This structure would consist of a pipe and a weir structure through which effluent, when necessary, would outlet at the waterward face of the containment berm into the Willamette River. During filling, as water within the CDF begins to approach a level at which discharge would be necessary, filling would be slowed or stopped to prevent overflow. If discharge is necessary, water quality within the CDF would be sampled and characterized prior to discharge to confirm that water quality criteria will be achieved at the point of discharge from the CDF, to be established through agency consultation on ESA and to comply with the substantive requirements of CWA Section 401. A detailed water quality monitoring plan similar to that being developed with the Port of Portland would be required.

The 60 percent design indicates the surface cover of the CDF would consist of two layers. The lower layer, located above the confined contaminated sediment, would consist of suitable fill or dredged sediments that meet EPA's "imported material" requirements established in the December 2003 Technical Plans and Specifications for the McCormick & Baxter sediment cap. The top layer is the surface cover layer and assumed to be compacted crush rock in the current design (Anchor QEA 2011). Following completion of a CDF at Terminal 4, it may be possible for the Port of Portland or its tenants to utilize the land created by the CDF for water-dependent uses.

L2.2.7 Removal and Installation of Piling and Structures

Some piles and structures may need to be removed during dredging and capping. Temporary structures may also be installed for work area isolation, transloading, sediment containment, or fish exclusion during construction. Obsolete piles and dilapidated structures with low function, permanence, and lifespan may be removed. Major and minor structures with medium to high function, permanence, and lifespan are expected to remain in place. Temporary docks are expected to be relocated to allow access to contaminated material.

L3.0 POTENTIAL IMPACTS

This section provides an analysis of potential impacts of remedial activities based on conditions set forth in the EPA Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230). Section 230.11 of Subpart B of the guidelines provides the four conditions that must be met in order to make a finding that a proposed discharge complies with the requirements described in 40 CFR 230. These four conditions include:

1. No discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem so long as the alternative does not have other significant adverse environmental impacts.

2. No discharge of dredged or fill material shall be permitted if it violates any water quality standards, jeopardizes any endangered or threatened species, or disturbs any marine sanctuaries.

3. No discharge of dredged or fill material shall be permitted that will result in significant degradation of any waters of the United States, including adverse effects on human health or welfare or effects on municipal water supplies, aquatic organisms, wildlife, or special aquatic sites.

4. No discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken that will minimize potential adverse impacts.

The proposed remedial alternatives include remedial activities to be conducted primarily from RM 1.9 to 11.8. In addition, dredged contaminated sediment and soil removed from the Site would be transported within the federally authorized navigation channel down the lower Willamette River to the Columbia River and upstream to a potential transloading facility. Most of the significant adverse impacts of the proposed remedial alternatives are generally expected to occur in the lower Willamette River where active remediation would occur. However, potential impacts to the Columbia River have also been evaluated.

Alternative A will not result in further impacts on the existing physical, chemical and biological characteristics of the aquatic ecosystem, special aquatic sites, and human use of the Site. The current degraded conditions would continue to exist. Each of the other proposed remedial alternatives has a different level of impact on the physical and chemical characteristics of the aquatic ecosystem related to dredging, capping, in-situ treatment, ENR, and constructing a CDF (only for Alternatives E through I). Impacted acres from dredging, capping, in-situ and ENR increase from Alternative B to Alternative H, with Alternative I falling between Alternatives D and E in area of dredging and for capping. In-situ treatment is only a component of Alternatives B and D because capping and dredging in these alternatives do not address all principal threat waste areas. Alternatives E through I do not include in-situ treatment since dredging and capping address all of the principal threat waste areas. Even though short term impacts increase with each alternative, more contamination is actively addressed from each alternative from B to H. Actively addressing more of the contamination has beneficial long term impacts and short term impacts. Compensatory mitigation to replace lost habitat and forage area from the remedial activities would be required, as described in Section L6.

The following sections discuss the existing conditions and impacts of each technology on the different aspects of the Site.

L3.1 POTENTIAL IMPACTS ON PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE AQUATIC ECOSYSTEM

Potential impacts on the aquatic ecosystem are primarily associated with (1) removal of contaminated sediment by dredging that may discharge contaminants into the water column and the placement of in-water fill material, (2) containment or in-situ treatment of contaminated sediment by the placement of a cap or amendment such as activated carbon, and (3) in-water disposal of contaminated sediments in a CDF. Activities associated with ENR, including placement of clean material, and in-situ treatment (placement of activated carbon) would also have impacts on the physical and chemical characteristics of the aquatic ecosystem. Such impacts would not be anticipated from the application of MNR or institutional controls; therefore, these technologies are not addressed in the impact evaluation.

A summary of the acreage assigned capping, dredging, in-situ treatment, ex-situ treatment, ENR and MNR technologies by alternative is presented in Table 3.9-2 of the FS. Under Alternative A (No Action), no actions would be undertaken to remediate the sediments within the Site, and only current conditions are evaluated.

The Site is within a working harbor with ongoing industrial activities and contains a federally maintained navigation channel, extending nearly bank-to-bank in some areas, which allows transit of large ships into the active harbor. The navigation channel is maintained to a depth of -40 feet with an authorized depth of -43 feet, and extends from the confluence of the lower Willamette River with the Columbia River to RM 11.7. In addition, the Port of Portland and other private entities periodically perform maintenance dredging to support access to dock and wharf facilities. Dredging activity has greatly altered the physical and ecological environment of the river in Portland Harbor.

Much of the shoreline contains overwater piers and berths, port terminals and slips, and other engineered features. Armoring covers approximately half of the harbor shoreline, which is integral to the operation of industrial activities that characterize Portland Harbor. Riprap is the most common bank-stabilization measure. However, upland bulkheads and rubble piles are also used to stabilize the banks. Seawalls are used to control periodic flooding as most of the original wetlands bordering the Willamette in the Portland Harbor area have been filled. Constructed structures, such as wharfs, piers, floating docks, and piling, have been built largely to accommodate or support shipping traffic within the river and stabilize the river banks for urban development. Some river bank areas and adjacent parcels have been abandoned and allowed to revegetate, and beaches have formed along some modified shorelines due to relatively natural processes.

The proposed remedial alternatives should achieve the remedial action objectives established for the Site in a manner that is consistent with the current and future maritime uses of the river and harbor.

Development of the river has resulted in major modifications to the ecological function of the lower Willamette River. However, a number of species of invertebrates, fishes, birds, amphibians, and mammals, including some protected by the ESA, use habitats that occur within and along the river. The river is also an important rearing site and pathway for migration of anadromous fishes such as salmon and lamprey. Various recreational fisheries, including salmon, bass, sturgeon, crayfish, and others, are active within the lower Willamette River. A detailed description of ecological communities in Portland Harbor is presented in the BERA provided as Appendix G of the RI report.

L3.1.1 Substrate

This section discusses physical and chemical characteristics associated with the substrate, including material composition, elevation and topography, shoreline conditions, and contaminants. Studies completed during remedial design may draw different conclusions as to the characteristics of the existing substrate and habitat.

L3.1.1.1 Existing Conditions

In general, with no anthropomorphic impacts, substrate size and location is an indicator of a river's energy regime. Low energy regimes allow for smaller substrates, such as silt and clay, to settle out and build up, whereas high energy environments continually wash smaller sediments away, leaving behind larger and coarser substrates such as sand, gravel, and cobble. Much of the lower Willamette River is dominated by sands. The river widens between RM 11 and 10 and allows for a mosaic of sand, silt, and other mixed textures. The finest substrates[1] are located between RM 10 and 7 where the river is the widest. Significantly coarser substrates overlaying finer material are found in highly developed areas along the middle and the upper end of the Site (LWG, as modified by EPA 2016). **Figure L3-1** shows the existing substrate conditions within the Site.

Figures L3-2a-e shows shallow water areas with benthic forage potential. These areas were determined as those having small substrate size (less than 64 mm) with no debris covering the substrate. Although these areas contain benthic forage potential, they may be impacted by the presence of chemical contamination that limits forage opportunities.

The LWG conducted a sidescan sonar review of the Study Area in 2009, which identified scattered debris on the river bottom throughout the Study Area (see **Figures L3-3a-d**). The debris included miscellaneous unidentifiable objects as well as sunken ships,

[1] Fines are defined as sediments less than 63 microns in diameter that would pass through a through a No. 230 U.S. Standard sieve mesh. Based on the Wentworth Size Class, this includes coarse silt, medium silt, fine silt, very fine silt, and clay.

anchors, concrete slabs, and steel and wooden piles. As part of the proposed remedial alternatives, the anthropogenic debris identified in the active remediation areas will be removed, returning the river bottom to more natural conditions.

The shoreline condition within the Site as determined by the LWG shoreline condition line dataset and assumes the shoreline condition extends throughout the active channel margin zone (**Figures L3-3a-d**). As a result of filling, channelizing, and other shoreline modifications that have occurred since the 1850s, steep shoreline slopes are common throughout the lower Willamette River. In the Willamette Basin, these types of shoreline hardening alter the velocity and timing of river and stream flows, disconnect rivers and streams from their floodplains, and limit the establishment of native vegetation and the natural maintenance of gravel beds, which has an impact on the character of the substrate in the lower Willamette River (Willamette Restoration Initiative 2004).

L3.1.1.2 Dredging Impacts on Substrate

Removal of contaminated sediments through dredging will change the elevation and material composition of the substrate. The FS assumes that slopes in shallow areas would be restored to existing grade following remedial activities. Following dredging, a 12-inch thick sand layer will be placed over the dredged area to cover the exposed surface and isolate any dredge residuals and remaining contaminated sediment. In addition, dredging in shallow areas would be followed by placement of beach mix, consisting of rounded gravel typically 2.5 inches or less, in shallow areas. This layer would provide appropriate substrate habitat for colonization by benthic organisms. Exceptions to this are where armoring in erosional areas is required, as described in the next section.

Following excavation of contaminated soils on river bank areas, river bank slopes would be restored to a slope of less than 5H:1V where possible; however, current industrial and commercial operations may have structures that preclude obtaining this desired slope following remedial action. Additionally, many of the contaminated river banks extend into upland areas that preclude removal of the contamination to PRGs. Consequently, caps and other erosion control measures will likely need to be placed on much of these banks.

The placement of a clean sand residual layer and/or beach mix (in shallow areas) will provide an improvement over current physical substrate conditions in some locations by replacing anthropogenic debris or large rock with sand and/or gravel. In areas where armoring is required, adverse impacts to substrate would require compensatory mitigation to replace lost habitat and forage area, as described in Section 6.

L3.1.1.3 Capping, In-Situ Treatment, and ENR Impacts on Substrate

Several types of caps may be implemented in various portions of the Site: engineered caps, armored caps, reactive caps, and armored reactive caps. Engineered caps consist of a sand layer with an additional top layer of beach mix in shallow areas. Armored caps would be needed for erosional areas and would consist of a sand layer with a top layer of armor stone. Armored caps are also assumed to be placed on steep river banks and at river banks prone to erosive forces.

In areas where groundwater contamination has the potential to discharge to the river, reactive caps would be needed and would consist of a sand layer mixed with activated carbon, an additional layer of sand on top of the reactive layer, and beach mix at the surface in shallow water areas to provide appropriate substrate for foraging habitat. Armored reactive caps would be needed to secure reactive caps in erosional areas with an additional layer of armor stone. Reactive caps would also include significantly augmented reactive caps in areas where NAPL or not reliably contained PTW is left in place following removal. Significantly augmented reactive caps consist of 1 inch of organoclay mat, 17 inches of fine-grained sand or other low permeability material, 12 inches of sand, and a surface stabilization layer. Within intermediate, navigation channel/future maintenance dredging areas, and shallow areas beneath structures, the surface stabilization layer is defined as 6 inches of armor stone. For shallow areas that are not beneath structures, the surface stabilization layer is defined as 6 inches of beach mix.

Cover materials for capping, in-situ treatment, and ENR would be selected to approximate common substrates found in the area and provide suitable habitat for benthic organisms native to the lower Willamette River. As with dredging, beach mix consisting of rounded gravel typically 2.5 inches or less would be applied to the uppermost layer of all cap surfaces in shallow areas.

The placement of engineered caps with riprap armor is limited to areas below heavy structures and as part of significantly augmented reactive caps. Placement of armoring materials in shallow water areas where there is currently no armoring would have an adverse impact to shallow water habitat by permanently altering the substrate. However, re-deposition of fine-grained material in capped and armored areas is anticipated to occur over time, making the armored areas similar in surface grain size to non-armored areas.

Overall, containment technologies will alter the chemical conditions of the substrate and result in benefits to the aquatic ecosystem by reducing exposure to contaminants in sediment, porewater, and surface water. However, the use of beach mix, where feasible, is expected to help minimize the adverse impacts of capping-based technologies on shallow water habitat.

L3.1.1.4 CDF Impacts on Substrate

The construction of a CDF would result in long-term impacts on substrate, as existing shallow aquatic area available for benthic and water column foraging will be eliminated through filling to become upland.

L3.1.1.5 Removal and Installation of Piles and Structures Impacts on Substrate

The removal of piles and structures prior to dredging and capping and their replacement following construction, if required, would not significantly alter the substrate. Structures installed for transloading, work area isolation, sediment containment, or fish exclusion during construction would be removed following construction; therefore, no permanent alteration to substrate is expected from these activities.

L3.1.2 Suspended Particulates/Turbidity and Dissolved Oxygen

Turbidity is a term commonly used to describe the clarity (or conversely, the cloudiness) of water. Turbidity is related to the amount of suspended particulate matter in the water and is measured in nephelometric turbidity units (NTUs).

L3.1.2.1 Existing Conditions

In the lower Willamette River, average turbidity tends to be highest in fall and winter and under high flow conditions. USGS measures turbidity in Formazin Nephelometric Units [FNUs], which are similar to NTUs) at the Morrison Bridge, just upstream of the Site (USGS 2016). During water year 2015 (from October 2014 to September 2015, monthly minimum and maximum FNUs ranged from 0.5 to 15 during the in-water work window between July 1 and October 31 (USGS 2016).

Mean monthly dissolved oxygen (DO) levels (mg/L) measured at the same location during the same time period ranged from 6.53 to 9.32 (USGS 2016).

DEQ maintains water quality monitoring sites throughout Oregon. The most recent trends in water quality were measured by the Oregon Water Quality Index for 1997 to 2006 (DEQ 2007). Two monitoring sites are located in the lower Willamette River channel at RM 7.0 (BNSF Railroad bridge) and upstream of the Site at RM 13.2 (Hawthorne Bridge). The index analyzes a defined set of water quality variables and produces a score describing general water quality. The water quality variables used include temperature, DO, biochemical oxygen demand, pH, total solids, ammonia and nitrate nitrogen, total phosphorous, and bacteria. The score produced to describe general water quality ranges from 10 (worst case) to 100 (ideal water quality). Water quality at RM 7.0 was classified as “fair” (minimum seasonal average index score of 82), while the water quality at RM 13.2 was classified as “good” (minimum seasonal average index score of 85). Overall, there were no significant trends noted from 1997 to 2006 at RM 7.0, while at RM 13.2, a decreasing score was noted (DEQ 2007).

Factors leading to a decreasing trend may include increased levels of point or non-point source activity and/or decreased flows (DEQ 2007). In addition, results from the temperature monitoring data indicate that 68 percent of the values at RM 7.0 and 61 percent of the values at RM 13.2 collected during the summer exceed the temperature water quality standard of 68°F.

L3.1.2.2 Dredging Impacts on Suspended Particulates/Turbidity DO

Dredging and associated debris removal has the potential to result in significant adverse impacts related to turbidity and suspended particulate levels in the water column, particularly in near-bottom waters. Turbidity increases due to dredging are typically short term and localized in nature. Suspended sediment concentrations vary throughout the water column, with larger plumes typically occurring at the bottom, closer to the point of dredging. Even without suspended sediment controls, plume intensity decreases exponentially with movement away from the point of dredging both vertically and horizontally. In addition, increases in turbidity that result from dredging activities are typically of much less magnitude than increases caused by natural storm events (Nightingale and Simenstad 2001).

Turbidity increases during dredging are expected to be limited, short-term, and localized. However, there is likely potential for short-term localized impacts from elevated turbidity levels on fish and other aquatic species at the Site. Avoidance and minimization measures and BMPs described in Section 5 and the Preliminary BA will be employed during dredging to minimize the potential for increased suspended sediment and turbidity levels. Dredging operations will be monitored closely and managed carefully to minimize suspended sediment effects according to the applicable requirements for the proposed action, including any additional conditions to be established through agency consultation on ESA and to comply with the substantive requirements of CWA Section 401. Water quality monitoring will be conducted during dredging to avoid impacts related to exceedances of water quality criteria for turbidity, DO, and contaminants.

EPA prepared a Water Quality Monitoring and Compliance Conditions Plan (WQMCCP) that defined appropriate points of compliance for water quality standards around dredging activities for the Terminal 4 Removal Action which established the following points of compliance:

> "For this project, the outer boundary of the water area a distance of 100 meters from the approximate center of the Removal Action activity is defined as the point of compliance for all field parameters other than turbidity. The compliance point for turbidity is 100 meters beyond the inner harbor line."

During remedial design, a WQMCCP would be developed to establish monitoring requirements and corrective actions.

Turbidity increases during dredging are expected to be limited, short-term, and localized and would be minimized during dredging with the implementation of BMPs and avoidance and minimization measures described in Section L5 and the Preliminary BA.

During dredging, suspension of anoxic sediment compounds may result in reduced DO in the water column in the immediate dredging plume area. Reductions in DO levels would have adverse impacts on aquatic species, particularly those occurring low in the water column. The reduction in DO levels beyond background is expected to be limited in extent and temporary in nature. Based on a review of four studies on the effects of dredging on DO levels, LaSalle (1988) showed little or no measurable reduction in DO around dredging operations. A decrease in DO during dredging would not be expected due to the following: (1) the relatively low levels of suspended material generated by dredging operations; (2) counterbalancing factors in the river, such as tidal or current flushing; and (3) high sediment biological oxygen demand created by suspended sediment in the water column is not common (LaSalle 1988; Simenstad 1988) and is not expected to be an issue at the Site due to limited amounts of organic material expected to be present based on the results of sediment core sampling. In addition, compliance with water quality standards, including those to be established through agency consultation on

ESA and to comply with the substantive requirements of CWA Section 401, would be achieved through operational BMPs and avoidance and minimization measures, including monitoring during dredging.

L3.1.2.3 Capping, In-Situ Treatment, and ENR Impacts on Suspended Particulates/Turbidity and DO

The discharge of cap materials, in-situ treatment materials, and ENR sand, as well as the placement of the residual layer in dredged areas (together defined as remediation fill materials) has the potential to result in significant adverse impacts related to turbidity and suspended particulate levels. In contrast to dredging, turbidity increases arising from discharge of remediation fill materials is expected to dissipate quickly due to the low level of organic material and larger grain sizes (sand/gravel) of the material to be used (NMFS 2005a). However, some localized short-term increases of turbidity above background river conditions could occur during placement of remediation fill materials. These localized turbidity/total suspended solids increases would be a short-term, minor adverse impact with implementation of the specific BMPs, avoidance, and minimization measures outlined in Section L5.

Placement of material for in-situ treatment and ENR is not expected to result in a change in sediment oxygen demand (and resulting DO reduction) during transport through the water column. There may be minor resuspension at the point of impact of the placed materials; however, this condition is expected to be temporary and localized, and the activity would be monitored by water quality testing.

L3.1.2.4 CDF Impacts Suspended Particulates/Turbidity and DO

During construction of the CDF berm, the use of coarser material with low fine content for the berm fill will minimize turbidity and DO impacts associated with material placement. BMPs and avoidance and minimization measures described in Section L5 will be employed during construction of the CDF to minimize the potential for adverse effects on aquatic species. After the berm is built, the CDF area would be enclosed from the river such that there would be no in-water work and a very low potential for impacts related to turbidity or decreases in DO.

L3.1.2.5 Removal and Installation of Piles and Structures Impacts on Suspended Particulates/Turbidity and DO

The removal of piles and, to a lesser extent, the replacement of piles and installation of structures could cause an increase in turbidity and decrease in DO. These adverse effects would be localized and short-term with implementation of the specific BMPs, avoidance, and minimization measures outlined in Section L5.

L3.1.3 Surface Water Quality

This section describes existing water quality conditions and potential impacts from the proposed remedial alternatives from potential resuspension of contaminants during construction activities. Additionally, accidental spills from construction equipment could expose fish to contaminants. However, standard and appropriate material handling and containment procedures and BMPs would be implemented to avoid or minimize impacts on aquatic species from accidental spills.

L3.1.3.1 Existing Conditions

The Willamette River from Willamette Falls to its mouth on the Columbia River is identified by Oregon DEQ as water quality limited under CWA section 303(d) for temperature, fecal coliform, biological criteria (fish skeletal deformities), and toxics (mercury in fish tissue, dieldrin, aldrin, PCBs, DDT/ DDE, dioxin (2,3,7,8-TCDD), PAHs, manganese, iron, and pentachlorophenol) (DEQ 2012).

Toxics
Surface water investigations conducted between November 2004 and March 2007 (LWG, as modified by EPA 2016). The BERA (Windward 2011) provides a comprehensive evaluation of potentially unacceptable risk to ecological receptors under conservative baseline exposure scenarios. Effects from lower Willamette River media on fish, including salmonids, were evaluated using tissue-residue, dietary, and surface water screening approaches. No whole body tissue sample concentrations in juvenile salmonids, were measured above toxicity reference values (TRVs). Whole body sample concentrations in other insectivorous fish (peamouth and sculpin), were measured above TRVs for copper, lead, PCBs, and DDx, but HQs were low.

Dietary evaluations indicated potentially unacceptable risk to juvenile Chinook salmon (*Oncorhynchus tshawytscha*) and other insectivores from cadmium, copper, mercury, and TBT. Individual surface water samples exceeded chronic aquatic life water quality criteria/standards or benchmarks for zinc; monobutyltin; benzo(a)anthracene; benzo(a)pyrene; naphthalene; bis-2(ethylhexyl) phthalate; DDx; ethylbenzene; and trichloroethene. All exceedance frequencies were less than 5 percent. Except for the PAHs, which had HQs ranging from 10 to 50, the magnitude of HQs was low, with the maximum only slightly exceeding 1, and the exceedances were not temporally or spatially consistent.

Storm water inputs, along with other known external source loads, including watershed/upstream, groundwater, and process water discharges (NPDES permitted discharges), represent a source of contaminants (particularly for PCBs) within the Site.

In addition to areas adjacent to the Site, land uses in the Willamette Basin upstream of the Site, such as agriculture, industry, transportation, and residential areas, historically and currently discharge municipal, agricultural, and industrial wastewater and storm water directly to the Willamette River and indirectly discharge through overland, overwater, and groundwater pathways, thereby contributing to chemical contamination of sediments within the Site and to nutrient loading and oxygen depletion in the surface water. Although private industries and municipalities within the river watershed began installing waste control systems beginning in the 1950s, the legacy of past waste management practices remains in the river bottom sediments (LWG, as modified by EPA 2016).

Upstream concentrations of chemicals in the surface water entering the Site already exceed one or more water quality standards, including Oregon and federal water quality standards/criteria for fish consumption, Oregon and federal freshwater chronic aquatic life water quality standards/criteria, and maximum contaminant levels (MCLs). Upstream surface water background levels of arsenic, dieldrin, total PCBs, total PAHs, 4,4´-DDT, sum DDT, and 2,3,7,8-TCDD exceeded Oregon water quality standards for fish consumption. Upstream surface water background levels of mercury exceeded Oregon chronic aquatic life water quality standards.

Contaminated Sediment Inputs to Surface Water Quality

Lower Willamette River sediment is a known contaminant source that can potentially impact surface water quality through diffusion and advection of pore water containing dissolved chemicals. Mechanical disturbances to sediment from propeller wash or in-water construction, as well as natural erosion and transport, may also result in releases to the water column.

The focused COCs identified in the FS for the Site are PAHs, PCBs, DDx, and dioxins/furans, which have the potential to become resuspended during mechanical sediment disturbance within the Site. However, the BERA identified a total of 93 COCs (as individual contaminants, sums, or totals) as potentially posing unacceptable ecological risk.

Exposure to dissolved aqueous phase organic compounds can potentially result in adverse effects to fish, including impacts on survival, growth, and reproduction. The BERA determined that relatively infrequent and low magnitude exceedances of water TRVs by surface water concentrations of organic compounds in the Site are not indicative of ecologically significant risk to fish. In contrast, exposure to organic contaminants in fish tissues poses potentially unacceptable risks to wildlife and people. In addition, area-specific sediment concentrations of six metals (cadmium, chromium, copper, lead, mercury, and silver) were identified as potentially contributing to benthic toxicity. Desorption of metals from suspended sediments potentially occurs within the Site during sediment disturbance.

L3.1.3.2 Dredging Impacts on Water Quality

Physical disruption of the contaminated sediments during dredging is necessary to implement the proposed remedial alternatives, which could cause a temporary increase in dissolved and particulate phase concentrations of some chemicals in the vicinity of dredging activities. This occurs from resuspension of contaminated sediments, desorption of the contaminants from sediment particles to the water column, and release of contaminated pore water into surface water. This effect is expected to be most observable when dredging areas with the highest contaminant concentrations in sediments and less observable in areas with lower sediment contaminant concentrations. If aquatic species are present in the portion of the action area where dredging is occurring, they could potentially be at risk of exposure. Whether that exposure causes detrimental biological effects depends on the concentration of the contaminants in the water and the duration of exposure. If contaminant concentrations are great enough or if exposure persists over a long period of time, the potential risk of adverse effects or bioaccumulation of some chemicals increases.

Dredging is anticipated to impact water quality from resuspension of contaminants into the water column. The locations causing the most exceedances of water quality criteria generally would be in areas where the highest contaminant concentrations are being dredged and in backwater quiescent areas. Short-term (during construction) increases in water column concentrations is expected to occur intermittently during the dredging period and dissipate when dredging ceases.

The potential acute exposure of contaminants during dredging at the Site is likely associated with soluble compounds such as benzene, naphthalene, and chlorobenzene in addition to PAHs, PCBs, and DDx in a few potential dredging areas within the Site and their immediate vicinity. The vast majority of resuspended sediment settles close to the dredge within 1 hour, and only a small fraction takes longer to resettle (Anchor Environmental LLC 2003). Therefore, a majority of the contaminants in the particulate fraction resuspended by dredging may not have time to desorb before they resettle to the sediment bed. If ingested, the particulate bound portion of chemicals can also be toxic or contribute to bioaccumulation of chemicals in an organism’s tissue.

The potential exposure to resuspended chemical contaminants related to dredging within the Site is expected to occur intermittently during the 4 month in-water work window. Dredging is assumed to occur 24 hours per day and 6 days per week. Based on estimated dredge volumes and production rates and estimated cap material volumes and application rates, in-water construction activities for the remedial alternatives are estimated to range between 4 to 62 years to complete.

In summary, although there may be a potential risk to aquatic species from short-term exposure to resuspended chemical contaminants within the Site, the long-term sediment quality improvements associated with the remedial alternatives will lead to benefits for aquatic species by reducing exposure to a known source of chemical contamination. The avoidance and minimization measures, including BMPs are described in Section L5.

L3.1.3.3 Capping, In-Situ Treatment, and ENR Impacts on Water Quality

During placement of remediation fill materials, there would be minor impacts on water quality from disturbance of the sediment bed containing contaminants. These water quality effects are anticipated to be of short duration, lasting a few hours, and limited to the immediate vicinity of the work area with implementation of the avoidance and minimization measures and BMPs described in Section L5.

As with dredging, the capping, in-situ treatment, and ENR activities will result in overall long-term benefits from substantial decreases in exposure to contaminants in sediment, porewater, and surface water.

L3.1.3.4 CDF Impacts on Water Quality

The use of a CDF to contain contaminated sediments will not result in long-term impacts on surface water quality, as the CDF will be designed to meet water quality standards in perpetuity, including chronic ambient water quality criteria, both aquatic and human health, and drinking water criteria in consideration of ambient background conditions. During construction of the CDF berm, BMPs and avoidance and minimization measures described in Section L5 will be employed to avoid and minimize the potential for adverse effects on aquatic species from resuspension of contaminants in sediment.

The CDF berm will include a weir and outfall structure that will be used to drain water into the Willamette River from the CDF as it is being filled with sediment. This structure would consist of a pipe and a weir structure through which effluent, when necessary, would outlet at the waterward face of the containment berm into the Willamette River. Filling the CDF will be slowed or stopped to prevent overflow as water within the CDF begins to approach a level at which discharge would needed. If discharge is necessary, water quality within the CDF will be sampled and characterized prior to discharge to confirm that water quality criteria will be achieved at the point of discharge from the CDF. Other requirements on discharge from the CDF may be established through agency consultation on ESA and to comply with the substantive requirements of CWA Section 401.

During construction of the CDF berm, BMPs and avoidance and minimization measures described in Section L5 would be employed to avoid and minimize the potential for adverse effects on aquatic species from resuspension of contaminants in sediment.

Once construction of the CDF berm is complete, the CDF will be fully enclosed from the river, limiting potential water quality impacts during filling. Potential release of contaminated sediments during barge transport to the CDF, or to trucks for access to the CDF from the shore, would be minimized according to BMPs outlined in Section L5.

Long-term monitoring of the CDF will include evaluating physical stability of the CDF berm during and following high flow and flood events and groundwater quality monitoring of the CDF and berm. To facilitate groundwater monitoring beneath the CDF and berm, groundwater wells will be installed during final CDF capping activities. Placement of dredged material in a CDF would result in surface water quality impacts, but these effects would be largely confined to the CDF.

L3.1.3.5 Dewatering and Transport of Dredged Sediments Impacts on Water Quality

Wastewater generated during dewatering of dredged material would require treatment prior to discharge to the lower Willamette River or disposal at a POTW facility. A detailed water quality monitoring plan would be required to comply with water quality criteria for discharge to the lower Willamette River.

During transport of dredged material for upland disposal, impacts on water quality would be avoided and minimized with implementation of the BMPs and avoidance and minimization measures outlined in Section 5. Transport containers (truck, rail, and barge) would be sealed to contain sediments and water, and spill-control equipment would be kept on hand to respond to releases.

L3.1.3.6 Removal and Installation of Piles and Structures Impacts on Water Quality

The removal of piles and the replacement of piles and installation of structures could cause contaminants in sediments to be resuspended. This impact would be localized and short-term with implementation of the specific BMPs, avoidance, and minimization measures outlined in Section L5.

L3.1.4 Current Patterns, Water Circulation, and Normal Water Fluctuations

This section describes existing conditions at the Site with respect to currents, water circulation, and normal water fluctuations, including tidal influence, and potential effects to these conditions from the proposed remedial alternatives.

L3.1.4.1 Existing Conditions

Today, the Willamette River is noticeably different from the river prior to industrial development that commenced in the mid to late 18th century. Historically, the Willamette River was wider, with more sand bars and shoals, and flow volumes were subject to greater fluctuation. The main river now has been redirected and channelized, several lakes and wetlands in the lower floodplain have been filled, and agricultural lands converted to urban or industrial areas. The result is a river that is deeper and narrower than it was historically, with higher banks that prevent the river from expanding during high-flow events (LWG, as modified by EPA 2016).

River currents and water circulation in the lower Willamette River in the vicinity of the Site are influenced by hydrologic conditions in both the Willamette and Columbia rivers and are further affected by the operations of dams. With each major storm, the USACE is responsible for controlling the amount of water retained and then released from the dams at the end of the storm to dampen hydrographic peaks and valleys. The effect of the 13 dams on the Willamette River and its tributaries has generally been to reduce the spring high water flows with retention and storage of water through the system-wide management of reservoirs.

Higher current speeds occur in the deeper portions of the river channel, and lower speeds occur in the shallow areas, regardless of flow direction. In the deeper, offshore areas of the lower Willamette River, such as within the federal navigation channel and adjacent areas in the mainstem deeper than about -20 feet NAVD88, the movement of water appears to be controlled primarily by the physical shape of the river, both the cross-sectional area and anthropogenic alterations such as borrow pits, dredged areas, and structures (LWG, as modified by EPA 2016).

Low water typically occurs between September and early November prior to the initiation of the winter rains (U.S. Geological Survey 2016). High water events can occur in the winter and from late May through June; a distinct and persistent period of relatively high water levels occurs when Willamette River flow into the Columbia is slowed by high-water stage/flow in the Columbia River during the spring freshet in the much larger Columbia River Basin. The Columbia River flow drops as the summer progresses, and this effect is diminished. During the winter, high seasonal flows on the Willamette River can be allowed to pass through to the Columbia River, which may have diminished flows due to retention at dams.

The lower reach of the Willamette River from RM 0 to approximately RM 26.5 is a wide, shallow, slow moving segment that is tidally influenced, with tidal reversals occurring during low flow periods as far upstream as RM 15. Currents generally flow downstream although reverse or upstream flows occur when the Willamette River flow is low and the tide is in flood stages. The tidal range varies throughout the year; a tidal fluctuation of approximately 4 feet was used for evaluations conducted during the RI (LWG, as modified by EPA 2016).

L3.1.4.2 Dredging Impacts on Current Patterns, Water Circulation, and Normal Water Fluctuations

Dredging may cause some temporary, localized changes in currents and water circulation due to the presence of the vessels and equipment required to conduct the activity. These potential temporary impacts are anticipated to be negligible because they will be insignificant localized impacts within the lower Willamette River. Following dredging in shallow areas, elevations would be restored to pre-dredge conditions. Therefore, impacts on currents, water circulation, and normal water fluctuations are anticipated to be negligible.

L3.1.4.3 Capping, In-Situ Treatment, and ENR Impacts on Current Patterns, Water Circulation, and Normal Water Fluctuations

As with dredging, the presence of the vessels and equipment for placement of remediation fill materials may cause some temporary, localized changes in currents and water circulation; however, these potential effects would be temporary and negligible. The FS assumes that the placement of remediation fill materials in shallow areas would require dredging of an equivalent cap thickness (maximum of 3 feet) prior to placement to allow for a net zero bathymetry change and avoid loss of shallow water habitat. Therefore, impacts on currents, water circulation, and normal water fluctuations are anticipated to be negligible.

L3.1.4.4 CDF Impacts on Current Patterns, Water Circulation, and Normal Water Fluctuations

Hydrologic Engineering Center (HEC) 2 modeling was conducted as part of the initial CDF design process to assess the potential impacts of the proposed CDF at Terminal 4 on Willamette River flood stage. The preliminary assessment of potential impacts on the

Willamette River showed that the rise in flood stage at and just upstream of Terminal 4 would be negligible (BBL, Inc. 2005).

L3.1.4.5 Removal and Installation of Piles and Structures Impacts on Current Patterns, Water Circulation, and Normal Water Fluctuations

The removal of piles and the replacement of piles and installation of structures could cause very localized changes in currents and water circulation; however, these potential effects would be negligible.

L3.1.5 Floodplains

Floodplain connectivity is highly degraded at the Site, and remedial activities would not alter these conditions. The potential for impacts on floodplain storage capacity is discussed in Section L3.1.4.4 related to impacts on normal water fluctuations. Based on HEC-2 modeling of the proposed CDF at Terminal 4, the rise in flood stage at and just upstream of Terminal 4 would be negligible. A HEC-RAS hydrodynamic model will be run to support the selected remedy in the ROD.

L3.2 POTENTIAL IMPACTS ON BIOLOGICAL CHARACTERISTICS OF THE AQUATIC ECOSYSTEM

This section describes existing conditions of, and potential impacts on, the biological characteristics of the aquatic ecosystem in the project area. Potential impacts are described for threatened and endangered species based on information presented in the Programmatic BA. The section also evaluates impacts on the aquatic food web, including benthic invertebrates, non-listed fish species, such as smallmouth bass, and wildlife.

L3.2.1 Threatened and Endangered Species

Several listed species occur within the project area, which includes both the lower Willamette River and the Columbia River. The listed species that have the potential to live within the project area and be impacted by the proposed remedial alternatives are listed in **Table L3-1**.

Some of the avoidance and minimization measures and BMPs described in Section 5 are specific to the protection of listed species but are also relevant to avoid and minimize effects on other aquatic species and wildlife in the project area.

L3.2.1.1 Existing Conditions

A detailed description of existing conditions related to habitat for listed species (also known as the environmental baseline) is provided in the Programmatic BA.

Other factors important for listed species in the project area include floodplain connectivity, natural cover, and habitat access and refugia. In general, these characteristics are degraded in the lower Willamette River due to the filling, channelizing, and shoreline modifications that have occurred during development and industrialization. The river has been disconnected from its floodplain, and there are few areas with mature, high quality riparian habitat throughout the Site. The typical bank condition is steep with poor substrate, which results in little to no emergent or submerged vegetation at the Site.

Although the natural cover condition within the Site is generally degraded, there are exceptions. Habitat access and refugia in the lower Willamette River have also been significantly impacted since the late 1800s, with approximately 79 percent of the shallow water habitat converted to deep water habitat within that time period.

L3.2.1.2 Remedial Activities including Dredging, Capping, In-Situ Treatment, ENR, and Removal and Installation of Piles and Structures Impacts on Threatened and Endangered Species

Remedial activities, particularly dredging, have the potential to result in adverse impacts related to turbidity and resuspension of contaminants. These effects would be relatively short-term and localized with the implementation of measures described in Section L5. However, there could be impacts on listed species, specifically juvenile salmon that could be present during in-water work. In addition, while elevation, slope, and substrate would be restored in shallow areas to the extent possible, there would be long-term adverse impacts in some areas, as follows:

- Natural Cover: While very limited in the action area, some river bank areas may support natural riparian cover that would be removed or disturbed during remedial activities, and it may not be possible to restore natural cover on site in all of the areas where it is disturbed.
- Substrate and Forage: Some areas of existing sand or gravel may be permanently lost with the placement of engineered caps that use riprap armor as a surface layer and where placement of beach mix as a top layer is not possible.
- Shoreline Armoring and Slope: As described above, some armoring would occur in shoreline areas, and it may not be possible to restore ideal slopes.
- Habitat Access and Refugia: In some areas, dredging may be required to a depth such that shallow water would be converted to deep water and/or there would be loss of shallow water habitat complexity, reducing the amount of shallow water habitat and refugia available.

Compensatory mitigation would be required to address these impacts, as described in Section L6.

L3.2.1.3 CDF Impacts on Threatened and Endangered Species

At the proposed Terminal 4 CDF location, approximately 14 acres of aquatic habitat would be converted to upland, resulting in permanent loss of aquatic habitat. Of the 14 total acres of aquatic habitat lost, approximately 3 acres, or about 20 percent of the total aquatic habitat, would be shallow water habitat (less than 20-feet deep). This would be an adverse impact to listed species, and compensatory mitigation would be required, as described in Section L6.

L3.2.1.4 Entrainment

In-water work will take place during the in-water work windows, and avoidance and minimization measures and BMPs will be implemented to reduce the potential for fish to be entrained or come in contact with construction equipment. In general, fish that are present within work areas during construction would be expected to avoid or rapidly move away from construction areas and other locations of active disturbance. For other dredging projects, NMFS has found that injury or death to listed salmonids as a consequence of entrainment is expected to be minimal based on timing restrictions for shallow water work, operational BMPs, and the fact that salmonids can usually avoid dredging activities (NMFS 2005b).

Silt curtains and sheet piling may be used in localized areas to prevent migration of highly contaminated sediment during dredging or during disposal operations. Entrainment during these activities would be avoided with the implementation of the fish capture and removal measures within the silt curtain or sheet piling containment structures in coordination with NMFS and other agencies, as appropriate, as described in Section L5.

During construction of a CDF, entrainment of fish behind the isolation berm or structure is also possible. To avoid trapping any fish, fish would be removed or excluded from the work area. The strategy for fish removal will be determined during remedial design but is likely to be conducted with the use of electrofishing, beach seining, purse seining, and fyke nets.

L3.2.1.5 Noise

Overall, the activities associated with the proposed remedial alternatives, except piling removal and installation, are not expected to create a noise impact on aquatic species. Construction noise is not likely to increase noise levels above ambient levels in water and out of water. However, in-water noise could be elevated as a result of pile installation activities. Pile driving activities are proposed in the lower Willamette River, and salmonids could potentially be present during the installation activity. It is assumed that pile driving operations would use the vibratory hammer method. If impact pile driving is proposed, it will be evaluated during remedial design.

Vibratory pile driving produces noise levels that are less than those generated during impact pile driving (Washington State Department of Transportation [WSDOT] 2015) under similar conditions. Noise from the vibratory hammer installation of piles has not been found to cause barotraumas to fish (physical injury documented to result from impact pile driving) because the vibratory pile extractor noise does not have the rapid-rise peak pressure that is characteristic of impact pile driving (WSDOT 2015). As such, no measurable effects on salmonids are expected to result from vibratory pile removal or installation activities.

Additional impacts on threatened or endangered species may be identified during coordination and discussions with the ESA agencies.

L3.2.1.6 Lamprey Ammocoetes

Although Pacific lamprey are not an ESA-listed species, they are designated as a species of concern by USFWS due to their cultural significance and declining populations. Pacific lamprey ammocoetes may be present in sediments year-round in the project area, particularly in depositional areas such as in low velocity pools and stream margins. Ammocoetes are particularly vulnerable to remedial activities, such as dredging and capping that would be implemented under the proposed remedial alternatives.

USFWS has recommended BMPs be implemented prior to dredging, capping, and other sediment disturbance to avoid and minimize impacts on lamprey ammocoetes in accordance with a Conservation Agreement between local tribes, states, federal agencies, non-governmental organizations, and other stakeholders (USFWS 2012). These recommendations include electrofishing surveys for the presence of lamprey ammocoetes prior to construction. During implementation of the remedial action, measures for protection of Pacific lamprey ammocoetes in sediment would be consistent with BMPs outlined in USFWS 2010.

L3.2.2 Aquatic Food Web

This section describes the existing conditions at the Site with respect to the aquatic food web, primarily focused on benthic and water column invertebrates, which represent the primary food source for many fish and aquatic species in the project area. Potential impacts on these communities are then discussed.

L3.2.2.1 Existing Conditions

Various aquatic invertebrate surveys, along with a study of juvenile salmonid diets, have been conducted in the lower Willamette River, as summarized below:

- Ward et al. (1988) conducted benthic surveys in and around Portland Harbor and found the dominant species to be oligochaetes and cladocerans. The study also commonly found amphipods and chironomids.
- Windward Environmental conducted a survey of the benthic and epibenthic community within the Site and found an abundance of oligochaetes, chironomids, and the amphipod *Corophium* spp (LWG, as modified by EPA 2016).
- A study of macroinvertebrates and zooplankton in the lower Willamette River using a variety of gear types found an abundance of cladocerans (bosminids and Daphnia), copepods, aquatic insects (including chironomids), and oligochaetes (Friesen et al. 2004).
- In Friesen 2005 study, the species diversity in various habitat types was investigated. Overall, the study found few differences in the proportional distribution of major taxa groups among habitat and concluded that the lower Willamette River is a generally homogenous community (Friesen 2005). Despite this finding, there were general trends that were identified: beaches tended to have relatively high species diversity, whereas seawalls were found to have relatively low densities and diversity. Aquatic insects appeared to prefer rock outcrops and

floating structures. Rock riprap sites had very high densities of invertebrates and relatively high diversity (Friesen 2005).

- A 2009 study by SWCA Environmental Consultants (SWCA) conducted benthic macroinvertebrate sampling in downtown Portland. They found an invertebrate community with a similar composition as found in other studies. Specifically, they identified a high abundance of oligochaetes, chironomids, the amphipod *Americorophium* sp, the polychaete *Manayunkia speciosa*, and the clam *Corbicula fluminea*. Salmonids are known to feed on chironomids and amphipods. These species were found at depths ranging from 11 to 79 feet and in substrates ranging from medium silt to medium gravel (SWCA 2009).
- A 2004 salmonid diet study identified the water column invertebrate *Daphnia* sp. as the most abundant species in the stomachs of juvenile Chinook (larger than 99 mm) and coho by both abundance and wet weight in the lower Willamette River throughout a majority of the year. These water column species are also in high abundance in the lower Willamette River. The study also found the amphipod *Corophium* sp. and both aquatic and terrestrial insects to be a common component of salmonid diets (Vile et al. 2004).

These studies documented both water column and benthic salmonid prey items available in the lower Willamette River across most habitat types, including riprap. The cladoceran *Daphnia* was found in abundance throughout the lower Willamette River although Bosminidae (another cladoceran group) was found to be more abundant (Friesen et al. 2004).

The distribution of invertebrate communities varies across the Site. In general, sheltered areas away from anthropogenic disturbance should support well-developed infaunal invertebrate communities that are characteristic of large river systems. Conversely, exposed nearshore areas, particularly around berths, docks, and boat ramps, likely have limited benthic communities due to the greater physical disturbance in these areas. Tidal and seasonal water level variability and nearshore disturbances (such as boat wakes) have a much larger effect in shallow water than they do in deeper water. The hard surfaces of the developed shoreline provide habitat for an epibenthic community. The navigation channel habitat is subject to hydrodynamic forces, the impacts of navigation, natural sediment deposition, bed load transport/erosion, and periodic navigational dredging. These forces vary spatially, resulting in the presence of both relatively stable and unstable sedimentary environments and patchy infaunal and epibenthic communities (LWG, as modified by EPA 2016).

L3.2.2.2 Remedial Activities including Dredging, Capping, In-Situ Treatment, ENR, and Removal and Installation of Piles and Structures Impacts on the Aquatic Food Web

Remedial activities that disturb the sediment surface will temporarily remove the biologically active zone and associated benthic communities. Recovery times for benthic communities following remedial activities are expected to be on the order of months. The Biological Opinion (BO) for the lower Columbia River Channel Improvement Project indicates that benthic organisms recolonize dredge locations rapidly (NMFS 2005a). A study completed in the Columbia River estuary indicates that recolonization usually occurs between a few and several months (McCabe et al. 1996, McCabe et al. 1998). NMFS found that maintenance dredging in the navigation channel, as well as the side channels, is likely to temporarily reduce the suitability of the sediment for recolonization by copepods (C. salmonis) by reducing the organic matter content of the sediments and altering sediment particle size; therefore, some prey species would be lost. According to the NMFS BO, "these changes in prey availability are unlikely to be of a magnitude or extent that would appreciably diminish forage resources in the action area" (NMFS 2005a). Benthic communities are expected to recover similarly for areas where in-water fill material is placed.

Following dredging, a 12-inch thick sand layer would be placed over the dredged area to cover the exposed surface and isolate any dredge residuals and remaining contaminated sediment. Most caps, as well as placement of in-situ treatment and ENR material, would also consist of a top layer of sand. In addition, beach mix, consisting of rounded gravel typically 2.5 inches or less, would be applied to the uppermost layer of all caps and dredge leave surfaces in nearshore areas. This layer would provide appropriate substrate habitat for colonization by benthic organisms. Beach mix would not be applied to leave surfaces consisting of sand unless required due to changes in hydrodynamic conditions following remedial activities.

In many areas, the physical and chemical improvement in substrate type as a result of the removal of contamination and placement of the dredge residuals cover layer may promote a more productive benthic community through recolonization on uncontaminated material. However, the placement of armor as a surface layer on top of an existing sand or gravel beach substrate in shallow water areas would lead to a long-term impact to benthic communities that were established in the sand/gravel substrate. Re-deposition of fine-grained material in capped and armored areas is anticipated to occur over time, making the armored areas similar in surface grain size to non-armored areas and reducing the adverse impact. However, in areas where armoring is required, adverse impacts would require compensatory mitigation, as described in Section L6.

Overall, remedial activities will benefit the aquatic ecosystem by reducing exposure to contaminants in sediment, porewater, and surface water. The most significant predicted improvement would be the reduction in fish and invertebrate tissue of PCBs, dioxin/furans, DDx, and other contaminants. This would indirectly result in a minimization of exposure and potential adverse effects to higher trophic level organisms.

L3.2.2.3 Use of Activated Carbon Impacts on the Aquatic Food Web

Several studies have examined the potential adverse effects to aquatic species, especially benthic invertebrates, from the use of activated carbon in capping and in-situ treatment materials (Cho et al 2009; Ghosh et al 2011; Beckingham et al 2013; Jonker and van Mourik 2014). Adverse effects to benthic invertebrates or other aquatic species from the use of 5 percent or less activated carbon in capping or in-situ treatment materials appear to be limited. Activated carbon works primarily by retarding contaminant transport through the cap and acting as a barrier between the contaminated sediment and the new benthic layer, thus, preventing exposure of the benthic and pelagic communities to the contaminants. This would be a significant benefit to listed salmonid and other aquatic species in the lower Willamette River.

L3.2.3 Wildlife

This section describes the common wildlife species and limited habitat in the project area. Potential impacts on these species are also discussed.

L3.2.3.1 Existing Conditions

A diverse group of birds and a small number of aquatic or aquatic-dependent mammals are known to live in habitat areas in the lower Willamette River. Birds that use the lower Willamette River represent various feeding guilds and include many migratory and resident species. Resident birds, such as bald eagle, Canada goose, mallard, spotted sandpiper, great blue heron, and many others, are found in the project area. Mammals that use the lower Willamette River include mink, river otter, beaver, muskrat, raccoon, and California sea lion. Habitat to support amphibians is limited within the Site as most local species prefer undisturbed areas that offer seasonal wetlands with emergent plants and shallow waters. Similarly, most local reptile species prefer wet vegetated upland habitats that are very limited at the Site. The benthic invertebrate community at the Site is dominated by worms, midge (fly) larvae, amphipods (small shrimp-like animals), mayfly larvae, caddisfly larvae, flatworms, crayfish, and the invasive Asiatic clam *(Corbicula fluminea)* (effects on the benthic community are described in Section L3.2.2).

In addition, state sensitive wildlife species for the project area’s ecoregion are presented in **Table L3-2** (ODFW 2008). Suitable habitat for most of these sensitive species is not available in the project area.

Habitat for common wildlife species is limited to remnant, fragmented riparian forest patches that remain along some portion of the river banks. Approximately 4,600 linear feet (17 percent) of shoreline with natural cover is located within active remediation areas where there is a potential for an impact to occur if a remedial design extends to the riparian area. These habitat patches serve as connectivity corridors for various species of aquatic and shorebird species and semi-aquatic mammals to connect to larger areas of wildlife habitat within the area such as Harborton Wetlands, Oaks Bottom, Forest Park, and Powers Marine Park (City of Portland 2009).

In addition, shallow water areas and adjacent shorelines that support some riparian or emergent vegetation, woody debris, and other features may provide food and refuge. As a result, species that prefer slower water velocities, foraging opportunities, and cover and refugia provided by shallow water habitat, such as otter, mink, and juvenile salmonids, are confined to narrow strips of shallow water habitat between the shoreline and navigational channel.

L3.2.3.2 Remedial Activities including Dredging, Capping, In-Situ Treatment, ENR, and Removal and Installation of Piles and Structures Impacts on Wildlife

Water Quality

Potential impacts related to turbidity and water quality resulting from remedial activities will have a negligible impact on other wildlife. Turbidity and resuspended sediments would likely result in wildlife avoidance of construction areas during implementation of remedial activities. This impact would be localized and temporary in nature, and access to specific locations in the Site would be affected for only a portion of the in-water work window.

Noise and Human Disturbance

During remedial activities, noise, vibration, and increased presence of equipment and human activity would disrupt wildlife that may be present in habitats along the shoreline. This would likely cause birds and other wildlife to relocate to adjacent habitats during construction activities. It is anticipated that this disturbance would not be significantly increased over current conditions in the Site due to the high degree of activity already present in this industrial harbor setting.

Contact with Construction Equipment

Wildlife that are present within work areas during construction would be expected to avoid or rapidly move away from construction areas and other locations of active disturbance.

Substrate and Forage

Waterfowl and other wildlife species forage on aquatic invertebrates and vegetation. Sand and/or beach mix used as residual cover would provide a suitable substrate that would be quickly colonized by benthic invertebrates (within several months), and compensatory mitigation would replace lost habitat and forage area, as described in Section L6. Water column invertebrates, such as *Daphnia* sp., are expected throughout the water column in many areas of the Site, and impacts resulting from short-term reduced water quality are not expected to be at a level that would affect the abundance of these ubiquitous prey items. Overall, reductions in contaminant exposure would provide an improvement over existing conditions for the aquatic food web and, therefore, to other wildlife.

Riparian Habitat

Remediation of some river bank areas with known contamination would occur during construction of the remedial action. While most of these river bank areas are highly industrial and consist of developed areas or steep, armored slopes with blackberry and other non-native vegetation, some areas may support natural riparian cover that would be removed or disturbed during remedial activities. Following remedial activities, natural cover in these areas would be restored to the maximum extent possible; however, this may not be possible in some areas with steep slopes, and compensatory mitigation would be required, as described in Section L6.

During remedial design, habitat assessments prior to construction to identify the presence of sensitive wildlife species and comply with restrictions to avoid or minimize impacts. This would include restrictions on removal or disturbance of riparian vegetation to avoid impacts on nesting migratory birds.

L3.2.3.3 CDF Impacts on Wildlife

At the proposed Terminal 4 CDF location, approximately 14 acres of aquatic habitat would be converted to upland, resulting in permanent loss of aquatic habitat. This would be an adverse impact on wildlife species that may utilize this habitat. In addition, the construction and use of a CDF would reduce the amount of natural cover if the footprint would cover riparian areas. Compensatory mitigation would be required to address this impact, as described in Section L6.

L3.3 POTENTIAL IMPACTS ON SPECIAL AQUATIC SITES

This section describes existing conditions and potential impacts on special aquatic sites.

L3.3.1 Sanctuaries and Refuges

This section describes existing sanctuaries, refuges, and areas designated by the City of Portland as "Special Habitat Sites" and discusses potential impacts on these areas from the proposed remedial alternatives.

L3.3.1.1 Existing Conditions

Sanctuaries and refuges are defined in 40 CFR §230.40(a) as "areas designated under State and Federal laws or local ordinances to be managed principally for the preservation and use of fish and wildlife resources." Three areas within close proximity to the Site are managed principally for the preservation and use of fish and wildlife:

- Oaks Bottom Wildlife Refuge
- Smith and Bybee Wetlands Natural Area
- Sauvie Island Wildlife Area

These three areas meet the federal definition of sanctuaries and refuges; however, the Oaks Bottom Wildlife Refuge is located 3 miles upstream from the Site and would not be directly affected by any of the proposed alternatives (**Figure L3-4**).

The Sauvie Island Wildlife Area is an approximately 11,500 acre state-owned game management area located west of the Site at the north end of Sauvie Island, at approximately RM 100 of the Columbia River just downstream of the confluence with the Willamette River (Oregon Department of Fish and Wildlife [ODFW] 2012). It was established in 1947 with the primary objectives of protecting and improving waterfowl habitat and providing a public hunting area (ODFW 2012). Sturgeon Lake, at 3,000 acres, comprises a large portion of the wildlife area and provides habitat to waterfowl and a number of warm water fish, including catfish, perch, and crappie. The lake also provides important off-channel foraging habitat for migrating juvenile salmonids. The management area includes water access for fishing and a boat ramp for small boat access. Trails are maintained throughout the management area for wildlife viewing and limited hunting activities.

The Smith and Bybee Wetlands Natural Area is an approximately 2,000-acre nature reserve characterized by an extensive network of sloughs, wetlands, and forests. The natural area is located 2 miles downstream of the Study Area on the east side of the lower Willamette River at the confluence with the Columbia River at RM 103 of the Columbia River. This area is managed by the Metro regional government as a natural area according to the terms of the Comprehensive Smith and Bybee Wetlands Natural Resource Management Plan (Oregon Metro Regional Government 2013). This area is also recognized by the Audubon society of Portland as a Priority Habitat Area. The Smith and Bybee Wetlands Natural Area is one of the largest protected wetlands in the United States (Portland Parks and Recreation [PP&R] 2011). It provides habitat to beaver, river otter, black-tailed deer, osprey, bald eagles, and Western painted turtles. The reserve includes a canoe launch and contains an extensive trail system for wildlife viewing.

In addition to the wildlife refuges listed above, there are a number of locations within the Site that have been identified in the City of Portland Natural Resource Inventory as "Special Habitat Sites" (City of Portland 2009), as shown in **Figure L3-4**:

- NW Willamette River Forested Wetland (RM 2.0)
- West Wye/I-5 Power Line Mitigation Site (RM 2.8)
- Harborton Forest and Wetlands Complex (RM 2.8)
- Willamette Cove Bottomland (RM 6.8)
- Swan Island Lagoon Beach and Wapato Wetland (RM 9.0)

L3.3.1.2 Remedial Activities including Dredging, Capping, In-Situ Treatment, ENR, and Removal and Installation of Piles and Structures Impacts on Sanctuaries and Refuges

The Sauvie Island Wildlife Area is located downstream of the Site between the Multnomah Channel and Columbia River and lacks a significant physical connection to the Willamette River. The Smith and Bybee Wetlands Natural Area is located downstream of the Site and may have a potential connection to the Willamette through the Columbia Slough at very high water flows. Turbidity and water quality impacts arising from remedial activities are expected to dissipate quickly and be mostly confined to within 100 meters downstream from the source, and because they occur during the summer months, are expected to be under low-water flow conditions. Therefore, no direct impacts are anticipated resulting from turbidity or water quality impacts on the Sauvie Island Area, and negligible impacts are expected for the Smith and Bybee Wetland Area. Removal of contaminants from within the Site may have a secondary beneficial impact on these areas.

Remedial activities, including dredging, capping, in-Situ treatment, EMNR, and removal and installation of piles and structures, are not anticipated to occur within any of the areas identified as Special Habitat Sites by the City of Portland. However, remedial activities may occur adjacent to these areas, as shown on **Figure L3-4**. As described in Section L5.4, measures would be implemented following remedial activities to restore substrate, slope, and natural cover to the extent possible to maintain habitat and function that would be altered during implementation of the remedial action, and compensatory mitigation would be required to address remaining impacts. Therefore, adverse impacts on Special Habitat Sites are not anticipated.

L3.3.1.3 CDF Impacts on Sanctuaries and Refuges

Construction of a CDF at Terminal 4 would not result in impacts on sanctuaries or refuges because there are no areas identified as Special Habitat Sites by the City of Portland at Terminal 4.

L3.3.2 Wetlands

In addition to being a navigable river of the United States, the Willamette River can also be characterized as a wetland under the Cowardin et al. (1979) system, a scientific rather than regulatory classification system. In contrast to the broader Cowardin scientific definition of wetlands, the CWA Section 404 guidance is slightly more narrowly focused on more “typical” types of wetlands and states:

“The term wetlands means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.” 40 CFR § 230.3(t).

The State of Oregon statutes at 196.800(16) and Oregon Administrative Rules at 141-085-0010 rely upon the CWA Section 404 definition to define jurisdictional wetlands. For the purposes of this evaluation, the Willamette River itself is not considered to be a wetland under the CWA definition but rather a water of the United States due to its navigability. However, there are specific locations within the Site that meet the CWA definition of wetlands, as described below.

L3.3.2.1 Existing Conditions

Anchor QEA mapped wetlands in the Study Area using existing information (National Wetlands Inventory and the State of Oregon wetlands information) and looking at hydric soils and vegetative cover to identify potential wetland areas (**Figure L3-5a-d**). The identified wetlands are based upon the Oregon wetland dataset and map the area from ordinary high water (OHW) to ordinary low water (Oregon Natural Heritage Information Center 2009).

According to the maps produced from the Oregon wetland data, aside from riverine wetlands, there are only two locations in the lower Willamette River below the OHW where other types of wetlands (in this case, Palustrine) are present, as shown on **Figure L3-5d**. One of these two areas is classified as palustrine scrub shrub wetland at RM 3, near the confluence of Multnomah Channel. There would be no remedial activities in this area; therefore, this wetland area would not be impacted. The other wetland area identified is a palustrine emergent seasonal at the head of Slip 1 at the Port of Portland’s Terminal 4. This wetland area would be impacted by the construction of the proposed CDF. Existing conditions for this wetland are described below.

The wetland area at Terminal 4 is described as a vegetated area in the shallow waters at the head of Slip 1 (BBL 2005). This areas supports shrubs and medium sized trees adjacent to the water and is occasionally submerged. It is surrounded by impervious surfaces in the upland and dock structures in the water. The slopes in the shoreline of this area are steep, and significant amounts of riprap are present (BBL 2005). Although ecological conditions in the slip may meet the definition of a wetland, the quality and function of this area as habitat is most likely constrained and impaired by industrial activity and surrounding upland development.

L3.3.2.2 Remedial Activities including Dredging, Capping, In-Situ Treatment, ENR, and Removal and Installation of Piles and Structures Impacts on Wetlands

Remedial activities, including dredging, capping, in-situ treatment, ENR, and removal and installation of piles and structures, are not anticipated to occur within wetland areas.

L3.3.2.3 CDF Impacts on Wetlands

Construction of a CDF at Terminal 4 would result in the permanent loss of wetland habitat in Slip 1. This would be a significant adverse impact on wetlands. This wetland is within the CDF footprint and confirmation of the wetland would be finalized in the 100 percent design of the CDF, if CDF is selected as a disposal option. Compensatory mitigation would be required to replace any lost wetland habitat, as described in Section L6.

L3.3.3 Mudflats

Mudflats are defined in 40 CFR §230.42 as “broad flat areas along the sea coast and in coastal rivers to the head of tidal influence and in inland lakes, ponds, and riverine systems.” Mudflats are generally composed of exposed mud and are established over time through sedimentation by rivers or tides. These habitat types support a variety of wildlife, particularly migratory birds. Due to extensive shoreline modifications, including riprap and seawalls, and historic maintenance dredging within the navigation channel, no mudflat areas are known to exist within the Site. Aerial imagery and documentation suggest that mudflats do not exist within the Site (USDA 2005, 2009). Review of the publicly available 2010 aerial imagery indicates that the mudflats have been altered or removed altogether, either as a result of shoreline development or dredging activities. The river plan for the north reach of the lower Willamette River, Natural Resources Inventory: Riparian Corridors and Wildlife Habitat identifies no mudflats existing within any of the North Reach inventory sites located within or adjacent to the Site (City of Portland 2009).

Because no mudflats are documented to exist within the Site, no impacts on mudflats would occur. It is expected that habitat assessments would occur prior to implementation of the proposed remedial alternatives, and any mudflat areas identified at that time would be assessed for potential impacts and the need for compensatory mitigation.

L3.3.4 Vegetated Shallows

Vegetated shallows are defined in 40 CFR §230.43 as "permanently inundated areas that under normal circumstances support communities of rooted aquatic vegetation, such as turtle grass and eelgrass, in estuarine or marine systems as well as a number freshwater species in rivers and lakes." Shallow water habitats are limited to the narrow strip between the shoreline and the navigation channel, which within the Site is vulnerable to disturbance and anthropogenic alteration due to its proximity to shoreline. Vegetated shallows may exist in some areas within the active channel margin and natural beach areas.

L3.3.4.1 Existing Conditions

Based on available information, vegetated shallows have been identified at a single location in the Site, at the head of the Terminal 4 Slip 1 (BBL 2005). This area is located adjacent to/contiguous with the palustrine wetland area described above and shown in **Figure L3-5d**. The Port of Portland determined that the vegetated shallows at Slip 1 are not likely to be habitat for mammals, such as mink, because of its degraded nature and isolation from other habitats (BBL 2005). The identification of other vegetated shallows would require fieldwork within the Site; effective assessments cannot be feasibly conducted through the review of aerial imagery. It is possible that additional sites may be located during habitat assessments conducted at the time of remedial design.

L3.3.4.2 Remedial Activities including Dredging, Capping, In-Situ Treatment, ENR, and Removal and Installation of Piles and Structures Impacts on Vegetated Shallows

Remedial activities, including dredging, capping, in-situ treatment, ENR, and removal and installation of piles and structures, are not anticipated to occur within vegetated shallows. It is expected that habitat assessments would occur prior to remedial activities, and any vegetated shallows areas identified at that time would be assessed for potential impacts. Avoidance and minimization measures described in Section 5 would be implemented following remedial activities and, if needed, any required compensatory mitigation.

L3.3.4.3 CDF Impacts on Vegetated Shallows

Construction of the proposed CDF at Terminal 4 would remove vegetated shallows resulting in a significant adverse impact. Therefore, compensatory mitigation would be required to address this impact, as described in Section L6.

L3.3.5 Riffle and Pool Complexes

Riffle and pool complexes are defined in 40 CFR §230.45 as areas of steep gradient streams with “rapid movement of water over a coarse substrate in riffles [that] results in a rough flow, a turbulent surface, and high dissolved oxygen levels in the water. Pools are deeper areas associated with riffles. Pools are characterized by a slower stream velocity, a streaming flow, a smooth surface, and a finer substrate.” Because the Willamette River within the Site does not have a steep gradient, and because it is channelized and the shoreline contains extensive modifications, including riprap and seawalls, it is highly unlikely that riffle and pool complexes exist within the Site; therefore, no impacts are anticipated. It is expected that habitat assessments would occur prior to remedial activities, and any riffle and pool complexes identified at that time would be assessed for potential impacts and the need for compensatory mitigation.

L3.3.6 Shorelines and Riparian Habitats

L3.3.6.1 Existing Conditions

The existing conditions of shorelines are described in Section L3.1.1.1, and **Figure L3-3a-d** shows the shoreline condition within the Site. The existing conditions of riparian habitats are described in Section L3.2.1.1 and Section L3.2.3.1, and the presence of natural cover along the shoreline is shown in **Figure L3-6a-e**.

L3.3.6.2 Remedial Activities including Dredging, Capping, In-Situ Treatment, ENR, and Removal and Installation of Piles and Structures Impacts on Shorelines and Riparian Habitat

The placement of engineered caps with armoring in shallow water areas where there is currently no armoring would have an adverse impact on shorelines. If beach mix cannot be used in an area, compensatory mitigation may be required to replace lost habitat and forage area, as described in Section L6 where armored caps are placed in shallow water.

Similarly, finished river bank slopes would be less than 5H:1V; however, current industrial and commercial operations may have structures that preclude obtaining this desired slope following remedial activities. Additionally, many of the contaminated river banks extend into upland areas that preclude removal of the contamination. Consequently, caps likely would need to be placed on many of these banks. Armored caps are assumed to be placed on river banks with steep slopes and on river banks in the main channel that are prone to erosive forces. Vegetation is assumed to be used for river banks in off-channel areas that are not prone to erosion and with less steep slopes. However, it may not be possible to restore natural cover in all of the areas where it is disturbed. Compensatory mitigation would be required to address this impact.

L3.3.6.3 CDF Impacts on Shorelines and Riparian Habitat

Construction of the proposed CDF at Terminal 4 would remove shoreline and riparian habitat resulting in a significant adverse impact, therefore, compensatory mitigation would be required to address this impact, as described in Section L6.

L3.3.7 Floodplains

Floodplain connectivity is highly degraded at the Site, and remedial activities would not alter these conditions. The potential for impacts on floodplain storage capacity from constructing the CDF at Terminal 4 is discussed in Section L3.1.4.4 related to impacts on normal water fluctuations.

L3.4 TRANSPORT OF CONTAMINATED SEDIMENTS TO TRANSLOADING FACILITY ON THE COLUMBIA RIVER

Potential release of contaminated sediments during transport on barges and transloading of barges to rail or truck would be minimized according to BMPs and avoidance and minimization measures outlined in Section L5. Barges would be sealed to contain sediments and water, and spill-control equipment would be kept on hand to respond to releases. Secondary containment would be incorporated into the design of transload facilities to capture contaminated materials that may escape from buckets while offloading barges or loading rail cars and trucks. If material is stockpiled at transload facilities, stockpiles would have curbing and sumps to facilitate the collection of runoff.

The specific location(s) of transloading facility along the Columbia River would be identified during remedial design. While not anticipated due to the industrial nature of potential transloading facility locations, potential impacts on aesthetics, noise, and other factors in the public interest would be evaluated during remedial design. Transportation of dredged material to upland disposal areas is not likely to impact water quality or aquatic or terrestrial wildlife.

L4.0 EVALUATION AND TESTING OF DISCHARGE MATERIAL

It is assumed that all capping and in-water fill material, including the residuals layer, would be obtained from a source that meets specifications established at the time of the remedial design. This would generally mean that any materials imported to the Site would have non-detectable levels of contaminants and are not expected to have significant adverse impacts on water quality or biota in the short or long term.

During remedial design, new baseline data would be collected to delineate SMAs and PTW. The performance criteria for the CDF significantly limits the ability of PTW to be disposed in the CDF. No additional testing of the sediment would be required to characterize the dredged or fill material for proposed placement in the CDF. Testing for water column effects, effects on benthos, biological community structure, and other physical tests and evaluations may be warranted at the design phase to address particular contaminant concerns or other site or action specific issues. Additional site-specific documentation of this testing may be required to demonstrate substantive compliance with 40 CFR 230.61 of the CWA 404(b)(1) guidelines.

In addition, this is supported by guidance at 40 CFR 230.60(c) which states:

"Where the discharge site is adjacent to the extraction site and subject to the same sources of contaminants, and materials at the two sites are substantially similar, the fact that the material to be discharged may be a carrier of contaminants is not likely to result in degradation of the disposal site. In such circumstances, when dissolved material and suspended particulates can be controlled to prevent carrying pollutants to less contaminated areas, testing would not be required."

The CDF area would be enclosed from the river after the berm is built, such that placement of material in the CDF would not involve in-water work and there would be no potential for discharges of contaminated sediment. During filling, as water within the CDF begins to approach a level at which discharge would be necessary, filling would be slowed or stopped to prevent overflow. If discharge is necessary, water quality within the CDF would be sampled and characterized prior to discharge to confirm that water quality criteria will be achieved at the point of discharge from the CDF, to be established through agency consultation on ESA and to comply with the substantive requirements of CWA Section 401. A detailed water quality monitoring plan similar to that being developed with the Port of Portland would be required. Additional discussion of the proposed CDF and impacts on water quality is provided in Section L3.1.3.4.

L5.0 IMPACT AVOIDANCE AND MINIMIZATION MEASURES

The avoidance and minimization measures described in this section are measures that may be taken to first avoid impacts on the aquatic environment. Where impacts may be unavoidable, measures to minimize the impacts may be taken. The avoidance and minimization measures described in this section were developed as part of the FS and informed by previous BA analyses and associated BOs for previous removal actions that have been conducted in the lower Willamette River, including Arkema, Gasco, and Terminal 4 Early Action sites. Detailed avoidance and minimization measures are provided in the Preliminary BA.

Some of the minimization measures described in this section were developed to serve as “on-site mitigation” to be integrated into the remediation plan to maintain habitat and function that may be altered during remedy implementation. As described in Section L5.4, these integrated minimization measures include the use of sand or beach mix as a final substrate layer following dredging and capping and the restoration of water depth, slope, riparian vegetation where possible, and river bank slope modification where applicable. These measures would be employed to avoid the need for compensatory mitigation (and are required to be considered prior to use of compensatory mitigation).

Given the general level of design in an FS, the degree of integrated minimization measures that may be conducted during implementation of the proposed remedial alternatives cannot be prescribed at this stage but will be determined during remedial design. Further, BMPs described in the FS in general are used for assumption purposes and therefore not final measures. It is expected that during remedial design all necessary avoidance and minimization measures and BMPs would be identified and implemented during construction. It is anticipated that compensatory mitigation pursuant to CWA Section 404 will be required to offset impacts that cannot be avoided or minimized through the use of on-site measures. General assumptions were used to estimate compensatory mitigation requirements for the FS cost estimates. The design level information on the CDF and associated unavoidable loss of aquatic habitat was also factored into the cost estimates. This is a useful and straightforward approach for the purposes of the FS, which is not expected to greatly impact the selection of the preferred alternative by EPA.

L5.1 IN-WATER WORK

To the maximum extent practicable conduct all in-water work within the approved in-water work window between July 1 and October 31.

The appropriate avoidance and minimization measures would apply to all in-water construction activities, such as:

- Monitoring – collection of biota for tissue sampling activities only
- In-place technologies
- Dredging and associated residual cover layer placement

- Construction of the CDF berm
- Removal and installation of pilings
- Construction of in-water portions of compensatory mitigation projects

Potential activities that can occur throughout the year, outside of an in-water work window, include but may not be limited to:

- Filling of the CDF once the berm is complete
- Surface sediment, surface water sample collection and monitoring
- Transport and offloading of dredged sediment for upland disposal
- Removal and replacement of light structures such as floating docks (without pile driving)
- Activities occurring in dry areas or over the water are expected to occur outside of the work window with proper measures in place to prevent construction materials from dropping into the water
- Activities occurring inside sheet pile wall containment that isolates the activity from the surrounding water column

Prior to implementing remedial activities, a WQMCCP would be developed). Monitoring and control requirements for dredging would include, at a minimum, turbidity, DO, and initial chemical constituent monitoring; sediment and contaminant dispersion control measures such as silt curtains, sheet pile walls, and closed or environmental dredge buckets; and BMPs. In addition, contingency measures and notification protocols should be included to address exceedances or observed injured or dead species.

Monitoring for COCs will be conducted for dredging and for certain capping projects to ensure BMPs are effective at reducing not only turbidity from the work, but also off-site migration of dissolved and particulate COCs. This monitoring may include measures like surface, mid water column, and near bottom water samples and other measures such as sediment traps. Site-specific plans should outline what COCs will be monitored and whether acute or chronic criteria will be applied. Plans would also make clear how tiered monitoring of turbidity and chemistry would work.

Dredging and capping activities would be conducted using general BMPs described in Section L5.2 and Section L5.3, respectively.

Removal of pilings will be conducted using general BMPs.

L5.2 DREDGING BMPS

Residuals and resuspension refer to contaminated sediments remaining in or adjacent to the footprint after dredging or sediment that may be disturbed and moves into the water column during dredging activities. All dredging causes some resuspension of sediment. Recent field analyses at other sites have shown that the mass of contaminants released during dredging is typically 1 percent of the total contaminant mass removed if a dredge residuals cover layer is placed soon after dredging, and if dredging BMPs are implemented (USACE 2013). Water-borne transport of re-suspended contaminated sediment released during dredging often can be reduced by using physical barriers around the dredging operation area, mechanical control techniques on the dredge equipment, and implementation of BMPs generally described in FS Section 2.

L5.3 BMPS FOR PLACEMENT OF MATERIALS FOR CAPPING, IN-SITU TREATMENT, AND ENR

As with dredging, placing in-water fill material will be conducted using the general in-water avoidance and minimization measures described below and the BMPs described in FS Section 2.

- The placement of material should generally occur starting at lower elevations and working to higher elevations.
- Set volume, tonnage, lead line measurements, and bathymetry information or similar should be used to confirm adequate coverage during and following material placement.
- Imported materials should consist of clean, granular material free of roots, organic material, contaminants, and all other deleterious material.

If an exceedance of water quality criteria is detected during any type of in-water construction activity, a sequence of responses should be initiated according to an approved water quality monitoring plan, including implementation of additional controls to be determined as needed. The details and sequence of the steps should be developed and presented during remedial design. As with dredging, operational controls (as opposed to a silt curtain or similar device) are considered the most effective measure for control of turbidity during placement of material.

L5.4 ON-SITE MITIGATION MEASURES FOLLOWING DREDGING AND CAPPING

Following dredging in shallow water areas (0 to 20 feet from ordinary low water), backfill would be used to restore the existing (pre-dredging) elevation to avoid loss of shallow water habitat.

To offset permanent and/or temporal loss of habitat functions from dredging and capping in shallow water areas and as on-site mitigation, following dredging and capping in shallow water areas, slope would be laid back to as close the existing slope as practicable given site-specific conditions.

To further offset permanent and/or temporal loss of habitat functions from dredging and capping on river banks and as on-site mitigation, after soil removal on river banks, river bank slopes would be laid back to as close as a 5H:1V slope as practicable given site-specific conditions.

Capping in shallow areas would specify dredging of an equivalent cap thickness prior to placement to allow for a net zero bathymetry change and avoid loss of shallow water habitat.

Engineered beach mix layer consisting of rounded gravel typically 2.5 inches or less would be applied to the uppermost layer of all caps and dredge leave surfaces in shallow areas. This layer would provide appropriate substrate habitat for colonization by benthic organisms. Beach mix would not be applied to leave surfaces consisting of sand unless required due to changes in hydrodynamic conditions following remedial activities. In addition, if beach mix is placed over riprap armoring, monitoring would be required to determine whether the site-specific conditions are conducive to maintaining the beach mix habitat layer over the riprap. If monitoring or site-specific modeling demonstrate that a sand/gravel surface can be maintained long term, this may be considered by EPA when determining if the compensatory mitigation proposed during remedial design is adequate.

Vegetation would be incorporated into caps placed on river banks where possible such as in off-channel areas that are not prone to erosion and with less steep slopes.

L5.5 TRANSPORT AND OFFLOADING OF CONTAMINATED SEDIMENTS FROM BARGE TO TRUCK OR RAIL

Transport and offloading of contaminated sediments to upland disposal facilities will require several measures and BMPs to avoid release of contaminants to surface waters during any step of transport or transloading.

L5.6 CONSTRUCTION OF A CDF

Avoidance and minimization measures and BMPs described above for dredging and placement of materials would be implemented during construction of the CDF berm to minimize the potential for increased suspended sediment and turbidity levels.

After the berm is built, the CDF area would be enclosed from the river such that there would be no in-water work and no potential for impacts related to turbidity. CDF fill rates will be controlled (and slowed as needed) to prevent berm overtopping. During filling, as water within the CDF begins to approach a level at which discharge would be necessary, filling would be slowed or stopped to prevent overflow. If discharge is necessary, water quality within the CDF would be sampled and characterized prior to discharge to confirm that water quality criteria will be achieved at the point of discharge from the CDF. EPA would coordinate with ESA agencies for additional measures as necessary. A detailed water quality monitoring plan would be required to comply with CWA Section 401.

L6.0 COMPENSATORY MITIGATION

During remedial design, remedial activities and avoidance and minimization measures would be fully developed. Based on those detailed plans, the need for compensatory mitigation projects to address the habitat functions potentially impacted by the remedial activities would be determined. Opportunities for mitigation projects that match the type and scale of impacts in the Site would be evaluated. It is anticipated that the performing parties would formally propose individual or group mitigation project(s) to fulfill the requirements identified.

Several on-site habitat avoidance and minimization measures would be implemented during and as part of remedial activities to avoid the need for compensatory mitigation. The FS assumes that a certain amount of compensatory mitigation for remedial technologies would be implemented in shallow water (0 to 20 feet MLLW) habitat as determined by changes to water depth and armored substrate. This is a useful and straightforward assumption for the purposes of the FS, which is not expected to greatly impact the selection of the preferred alternative by EPA.

Compensatory mitigation would be required to offset impacts due to the loss of approximately 14 acres of aquatic habitat with construction of a CDF at Terminal 4 (Anchor QEA. 2011). Of the 14 total acres of aquatic habitat, only 1.09 acres, or approximately 8 percent of the total aquatic habitat, would be in the less than 6-foot depth range, which is the most important depth stratum for juvenile salmonids. Within this 1.09 acres, over 85 percent is steep sloped, armored with large riprap, and/or covered with overwater structures. Additionally, a total of 2.19 acres would be within the 6- to 20-foot depth stratum, which represents about 16 percent of the total aquatic habitat impacted in Slip 1. Within this 2.19-acre area, there is a similar trend, whereby approximately 85 percent of the area is either steep sloped, armored with large riprap, and/or covered with overwater structures. A total of approximately 10.7 acres, or about 75 percent of the total aquatic habitat that could be impacted at T4 from construction of the CDF, is in the greater than 20-foot depth range, which is plentiful habitat in the lower Willamette River.

L6.1 IDENTIFICATION OF COMPENSATORY MITIGATION OPPORTUNITIES

General compensatory mitigation requirements (40 CFR 230.93) provides a hierarchy for selection of compensatory mitigation projects. The hierarchy in order of priority is:

- Purchase of mitigation bank credits
- Purchase of credits from an in-lieu fee program
- Permittee-led mitigation conducted on a watershed scale (based on a watershed plan or approach)
- Permittee-led mitigation through on-site (area located on the same parcel or contiguous parcel) and in-kind (replacement of a resource type similar in structure and functional type) mitigation

- Permittee-led mitigation through off-site (area located either on a different parcel of land and not contiguous to the impact site) and/or out-of-kind (replacement of a resource that is of a different structural or functional type) mitigation

In considering the impacts of the remedial technologies to be implemented, "on-site" is assumed to be within the Site and "off-site" would be within the appropriate watershed of the impact. Consistent with DSL mitigation bank requirements, compensatory mitigation would be implemented in the fourth level hydrologic unit code (HUC) watershed (the lower Willamette Sub-basin, HUC 17090012).

For the purposes of the Site and the remedial action, purchase of mitigation banking credits is contingent upon establishment of a bank within an appropriate service area. As of March 2016, there were no established banks with available credits that cover the Site or the overlap of the fourth level watershed (USACE 2016). Mitigation banking sites must be approved to provide compensatory mitigation for Section 404 impacts and not just Natural Resource Damage Assessment values.

As reflected in the hierarchy, mitigation banking may be a cost effective and ecologically sound way to compensate for unavoidable losses of aquatic resources. Purchasing mitigation credits reduces schedule and project costs by eliminating development of mitigation plans, multiple agency reviews of mitigation actions, and finding and acquiring land, among other steps necessary to conduct on-site or off-site mitigation. However, if mitigation banking credits are not available, alternative mitigation projects would be developed based on specific plans during remedial design.

It is assumed that compensatory mitigation projects would be constructed in the lower Willamette River and/or the Columbia River. These projects most likely would entail the conversion of existing upland habitat to shallow water habitat with sand/gravel substrates, shallow slopes, and shoreline complexity.

L7.0 ANALYSIS OF PRACTICABLE ALTERNATIVES PURSUANT TO SITE CRITERIA

The FS provides the analysis of practicable alternatives pursuant to the CERCLA criteria. A summary of the remedial alternatives evaluated in the FS is presented in Table 3.9-2 of the FS. As stated earlier, the purpose of the proposed remedial alternatives is to address the contaminated sediments at the Site to reduce risks to acceptable levels consistent with the RAOs. The FS evaluates the available alternatives, including discharge locations, capable of achieving this project purpose consistent with 40 CFR 230.10(a). However, given that disposal is not water dependent, a more detailed 404(b)(1) practicable alternatives analysis to an on-site confined disposal facility is addressed in more detail here.

L7.1 SITE AVAILABILITY

For the purposes of the FS, Site ownership and access to the remedial action areas was not addressed, and it is assumed that neither will be an impediment to the in-water actions. Therefore, this discussion is specific to site availability for a CDF location.

Pursuant to the CWA Section 404(b)(1) regulations, an alternative is practicable if it is available to meet and capable of meeting the project purpose, among other considerations. According to the regulations (40 CFR 230.1(a)(2)), “an area not presently owned by the applicant, which could be reasonably obtained, utilized, expanded, or managed in order to fulfill the basic purpose of the proposed activity may be considered.” EPA has determined that an alternative would be available if it is owned or could be reasonably obtained, used, expanded, or managed by the individual responsible parties. The proposed CDF, located at Terminal 4, would be owned by the Port of Portland, which has offered it as a possible disposal site. The other in-water disposal sites would be owned by the Oregon Department of State Lands and adjacent landowners.

The following sections describe the evaluation of disposal scenarios and CDF locations conducted for the FS.

L7.2 COST EFFECTIVENESS

Pursuant to the CWA Section 404(b)(1) regulations, a determination of practicability must consider if fill or disposal can be accomplished at a reasonable cost (40 CFR 230.10(a)(2)). Under CERCLA, EPA also must consider whether or not an action or remedy provides effectiveness proportional to costs. To determine cost effectiveness, the costs of the alternatives and their protectiveness were compared considering long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, and short-term effectiveness.

The FS Section 2 (Table 2.4-2) describes the results of the screening evaluation of the three potential CDF locations with respect to cost and finds that costs would be “high" for the Terminal 4 location, “high-very high” for Swan Island Lagoon and “very high” for Arkema. Capital and O&M costs for a Terminal 4 CDF would be approximately

$87/cubic yard and $1.5 million, respectively, based on the 60 percent design (Anchor QEA 2011). Estimated capital and O&M costs for a CDF at Arkema would be $166/cubic yard and $245,000, respectively. No cost estimates are available for a CDF at Swan Island Lagoon and were not developed in the FS. The comparative analysis assumes a cost of $93.20 per cubic yard for disposal at the T4 CDF (FS Table 4.3-2), which includes mitigation of the 14 acres of lost aquatic habitat. Off-site disposal cost is estimated at $166.50 per cubic yard ($111 per ton).

FS Section 4 presents an analysis of two disposal scenarios based on cost and finds that DMM Scenario 1 (which includes a CDF) represents a potential cost savings for each eligible alternative (Alternatives E through I) if it were to be implemented. A large capacity CDF such as Terminal 4 could be efficiently integrated with dredging because it would result in shorter transport distances and minimize the need to off-load at an offsite landfill.

L7.3 FEASIBILITY

When considering technical and administrative feasibility, EPA proposes the alternative that is most available and capable of achieving the project purpose in a manner that is designed to avoid unacceptable adverse impacts to the aquatic ecosystem to the maximum extent practicable.

L7.3.1 Technical Feasibility

FS Section 2 provides an evaluation of the three potential CDF locations: Terminal 4 (Slip 1), Swan Island Lagoon, and Arkema. Table 2.4-3 of the FS describes the results of the evaluation of these three sites based on effectiveness (long- and short-term), implementability (administrative and technical feasibility), and cost. Findings for effectiveness and implementability are as follows:

Effectiveness: A CDF at either the Terminal 4 or Swan Island Lagoon locations would be effective (both short- and long-term) if constructed and maintained properly. A CDF at the Arkema location may not be effective due to high levels of contamination offshore of Arkema and the presence of an uneven bedrock surface.

Implementability: A CDF at either the Terminal 4 or Swan Island Lagoon locations would be technically feasible based on the 60 percent design. No significant issues related to the location in the off channel area were identified that cannot be overcome through design. A CDF at Arkema would require rigid containment due to its location in the channel. In addition, basalt bedrock near the surface and deeper water near the navigation channel create challenges for isolation of contaminants with rigid containment at the Arkema location. It is uncertain if these challenges could be overcome.

All of the upland landfill options are constructed and operating, thus, they are technically feasible.

L7.3.2 Administrative Feasibility

Administrative feasibility refers to the requirements associated with coordinating with other offices and agencies, including statutory limits, waivers, and requirements for off-site actions.

Construction and maintenance of a CDF (at any location) presents administrative challenges. Construction of a CDF would increase the relative amount of construction for Alternatives E through I, and would require sequencing remedial projects for effective CDF use. There could also be potential disruption of navigation and other waterway uses throughout construction, filling, and closure of the CDF. Administrative challenges would include obtaining agreements among multiple parties for CDF use, costs, maintenance, and liability. Despite these administrative challenges, the CDF option is considered to be feasible in the FS.

As described in Table 2.4-3 of the FS, there are proponents identified for construction of a CDF at both the Terminal 4 (Port of Portland) and Arkema (LSS/Arkema) locations, but no current proponent exists for the Swan Island Lagoon location. The Port of Portland (and to some extent LSS/Arkema) have been in discussions with the Oregon Department of State Lands, who owns the lands within the footprint of the Terminal 4 and Arkema CDF locations. This may indicate greater administrative feasibility of the Terminal 4 location.

In addition, following completion of a CDF at Terminal 4, it may be possible for the Port of Portland or its tenants to utilize the land created by the CDF for water-dependent uses.

Use of the potential Swan Island CDF would eliminate or impact ongoing commercial water-dependent uses of this portion of the Site unless the channel end of the CDF was repurposed as a terminal slip. However, there is a lack of information on whether these potential uses are viable due to a lack of a proponent.

The upland landfill options are constructed and operating so are administratively feasible.

L7.4 AQUATIC IMPACTS FROM DISPOSAL

Potential aquatic impacts have been discussed extensively in Section L3.

Construction of the CDF would result in permanent loss of approximately 14 acres of aquatic habitat. The use of a CDF (DMM1) has the potential to reduce overall impacts to the environment compared to upland disposal (DMM2) of all removed sediments.

Upland disposal would not be permitted in areas with wetlands, streams, or other aquatic resources; therefore, there would not be any impacts on the aquatic environment from the upland disposal of material.

L7.5 CONSERVATION AND RECOVERY

Section L5.4 provides habitat avoidance and minimization measures that would be implemented following dredging and capping to avoid the need for compensatory mitigation. Section L6 describes the process for determining compensatory mitigation to account for unavoidable losses to aquatic functions.

L7.6 LIMIT NUMBER OF SITES

The location of discharge into the Site includes the active remediation areas as well as the location of the proposed CDF. The sizes and locations of the remedial action areas were determined through application of remedial action levels. This process is described in detail in the FS Section 3.

The technology screening process for disposal sites was conducted to assess a number of possible alternatives through the application of the effectiveness, implementability, and cost criteria. Upland disposal sites considered as representative locations in the FS include Roosevelt Regional Landfill (Subtitle D), and Chemical Waste Management of the Northwest (Chem Waste) Landfill (Subtitle C; accepts RCRA waste). As shown in **Figure L2-1**, a number of potential transloading facilities along the Columbia River are being considered as part of the disposal process.

The Port of Portland evaluated the use of a CDF at Terminal 4 in an engineering evaluation/cost analysis (EE/CA) (BBL 2004a, 2004b). Based on an evaluation of effectiveness, implementability, and cost, a CDF in Slip 1 of Terminal 4 was identified as a potential DMM scenario.

The Terminal 4 EE/CA and associated 404(b)(1) Analysis (BBL 2005) found that a CDF with excess capacity (beyond what was needed for the sediments removed at Terminal 4 itself) may facilitate more expedited sediment cleanup of the Site by providing additional disposal options for future cleanup decisions. Establishing an in-water disposal site within the Portland Harbor Site would reduce the overall environmental impacts and potential public safety implications associated with transport of materials to offsite disposal facilities using trucks or rail. Having both on-site and off-site disposal options also helps control the costs of disposal because it may create a more competitive market for off-site disposal. This, in turn, may encourage the consolidation of the contaminated sediments into a limited number of locations, which may reduce the area within the Willamette River where contaminated sediments would be capped and therefore potentially limited in future use.

L8.0 FACTUAL DETERMINATIONS

The following sections provide a summary of the preliminary determinations made for each component of the aquatic ecosystem evaluated in previous sections.

L8.1 PHYSICAL SUBSTRATE DETERMINATIONS

Remedial activities, including dredging, capping, in-situ treatment, ENR, removal and installation of piles and structures, and disposal of contaminated sediments in a CDF, will alter the material composition, slope, and elevation of the physical substrate. Elevation, slope, and substrate would be restored to the extent possible, and the placement of clean sand residuals cover and/or beach mix will provide an improvement over current physical substrate conditions in some locations by replacing anthropogenic debris or large rock with sand and/or gravel. In areas where armoring is required, adverse impacts to substrate would occur; however, re-deposition of fine-grained material in capped and armored areas is anticipated to occur over time, making the armored areas similar in surface grain size to non-armored areas. Compensatory mitigation to replace lost habitat and forage area from the placement of armor stone would be required to replace lost habitat and forage area and to compensate for other lost functions such as flood capacity. In shallow areas, beach mix will be used as much as possible for armoring and as the top layer of caps to provide appropriate substrate habitat for colonization by benthic organisms.

L8.2 WATER CIRCULATION AND FLUCTUATION DETERMINATIONS

Following dredging in shallow areas, elevations would be restored to pre-dredge conditions. The analysis presented in Appendix P indicates that impacts from these activities are anticipated to be negligible.

Impacts on floodplain storage from the construction of a CDF is anticipated to be negligible based on HEC-2 modeling (BBL 2005).

L8.3 SUSPENDED PARTICULATES AND TURBIDITY DETERMINATIONS

Impacts on water quality are anticipated to be greatest from debris removal and dredging compared to other remedial activities. Turbidity increases and DO decreases during debris removal and dredging are expected to be limited, short-term, and localized and would be minimized with the implementation of BMPs and avoidance and minimization measures described in Section L5. Water quality parameters would be monitored, corrective measures taken if levels exceed regulatory thresholds established for the proposed remedial alternatives.

L8.4 WATER QUALITY DETERMINATIONS

Physical disruption of the contaminated sediments during debris removal and dredging could cause a temporary increase in dissolved phase concentrations of some chemicals in the vicinity of dredging activities, resulting from resuspension of contaminated sediments, desorption of the contaminants from sediment particles to pore water, and release of contaminated pore water into surface water. Short-term increases in water column concentrations is expected to occur intermittently during the duration of the dredging and dissipate when dredging ceases. Water quality parameters will be monitored corrective actions implemented if levels exceed regulatory thresholds established for the proposed remedial alternatives.

L8.5 AQUATIC ECOSYSTEM AND ORGANISM DETERMINATIONS

Dredging activities will have temporary and localized adverse impacts on the aquatic ecosystem and organisms in the immediate dredging plume area. Remedial activities that disturb the sediment surface will temporarily remove the biologically active zone and associated benthic communities. Recovery times for benthic communities following remedial activities are expected to be on the order of months. In many areas, the physical and chemical improvement in substrate type as a result of the removal of contamination and placement of the dredge residuals layer may promote a more productive benthic community through recolonization on uncontaminated material. However, the placement of armor as a surface layer on top of an existing sand or gravel beach substrate in shallow water areas would lead to a long-term impact on benthic communities that were established in the sand/gravel substrate. Beach mix will be used as the top layer of caps to minimize the adverse impacts of the armoring. While re-deposition of fine-grained material in capped and armored areas is anticipated to occur over time, adverse impacts would require compensatory mitigation. Remedial activities are likely to adversely affect listed species and designated critical habitat at the Site. Compensatory mitigation would be required for impacts to listed species and designated critical habitat.

L8.6 DETERMINATION OF CUMULATIVE EFFECTS ON THE AQUATIC ECOSYSTEM

Cumulative impacts are defined as “the changes in an aquatic ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material. Although the impact of a particular discharge may constitute a minor change in itself, the cumulative effect of numerous such piecemeal changes can result in a major impairment of the water resources and interfere with the productivity and water quality of existing aquatic ecosystems” (40 CFR 230.11[g][1]).

As described in the RI (LWG, as modified by EPA 2016), the Site has been significantly modified by human activity in the last 100 years, resulting in present-day conditions that are highly altered and degraded. Maintenance dredging activities in the federal navigation channel, undertaken by USACE, have occurred in the past and would be expected to occur in the future.

In all alternatives, the same combination of technologies will be used. Under each alternative, it is assumed that only a certain number of projects can be completed during the specified in-water work window each year. The implementation of avoidance and minimization measures and BMPs described in Section L5 would avoid or reduce impacts on the aquatic ecosystem to the maximum extent possible.

Construction of a CDF at Terminal 4 would result in the loss of approximately 14 acres of total aquatic area (BBL, Inc. 2005). Shallow water habitat and vegetated shallows or wetlands are limited habitats in the lower Willamette River, with approximately 20 percent of the Site having shallow water habitat (LWG, as modified by EPA 2016). Based on this rough estimate, there are approximately 438 acres of shallow water habitat in the 2,167-acre Site. The amount of shallow water habitat will be verified during remedial design. As described in Section L3, high quality shallow water habitat with emergent vegetation, refugia, and appropriate substrate to support benthic forage opportunities is very limited in this industrial setting and likely impacted by the presence of chemical contamination. However, given the limited availability of shallow water habitat and its importance for juvenile salmon and other species, any loss of shallow water habitat would be a significant loss that would require compensatory mitigation.

The remedial activities will not result in significant detrimental cumulative impacts on the aquatic ecosystem. Although short-term adverse effects from implementation of remedial activities are expected, they would result in long-term benefits to the aquatic ecosystem by reducing exposure to contaminants in sediment, porewater, and surface water. The remedial action and compensatory mitigation, to be defined in the ROD and refined during remedial design, are expected to result in “no net loss” of aquatic resource functions.

L8.7 DETERMINATION OF SECONDARY EFFECTS ON THE AQUATIC ECOSYSTEM

Secondary effects (or impacts) are “effects on an aquatic ecosystem that are associated with a discharge of dredged or fill materials but do not result from the actual placement of the dredged or fill material” (40 CFR 230.11(h)(1)). Under CWA, secondary impacts are generally interpreted as indirect impacts; therefore, secondary effects are limited to other actions in the aquatic environment that are indirectly related to implementation of the action, such as erosion or downstream sedimentation. The remedial alternatives would be designed so that they would not contribute to erosion or downstream sedimentation.

It is assumed that compensatory mitigation will be required to be in compliance with CWA Section 404(b)(1) as well as to offset potential impacts on listed species. The compensatory mitigation could include purchasing mitigation banking credits. It could also entail construction of mitigation projects in the Site or within the larger watershed. Compensatory mitigation activities will not cause other significant impacts to occur that would adversely affect the aquatic environment in the Site.

L9.0 REVIEW OF CONDITIONS FOR COMPLIANCE

The potential for significant adverse impacts on the aquatic ecosystems resulting from implementation of remedial alternatives would be mitigated through the application of avoidance and minimization measures and compensatory mitigation. According to the compensatory mitigation regulations:

> "…no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (40 CFR 230.10 (a)).

The alternatives with the most potential for significant adverse impacts on the aquatic ecosystem are Alternatives E through I, which may include the DMM1 scenario (construction of a CDF).

L9.1 AVAILABILITY OF PRACTICABLE ALTERNATIVES

Section 230.10 of Subpart B of the compensatory mitigation regulations further specifies four general conditions that must be met for compliance. These include consideration of practicability, compliance with the ESA, protections for water quality and human uses, and compliance with the avoidance, minimization, and compensatory mitigation requirements. The results of the analyses are summarized below.

L9.1.1 Practicability (40 CFR Section 230.10(a))

A practicable alternative according to 40 CFR 230.10 is available and capable of being conducted after taking into consideration cost, existing technology, and logistics in light of the overall project purpose and needs. Activities that do not involve a discharge of material into waters of the United States include Alternative A (No Action). However, according to the proposed RAOs and purpose and need of the remedial action, this alternative does not meet the purpose and need and is not considered to be available per 40 CFR 230.10.

Alternatives B through I are evaluated for compliance with the definition of practicability in the FS.

Three potential CDF locations were also evaluated in the FS, and the results are summarized in Section L7. A CDF could be used for disposal of some of the dredged sediments under Alternatives E through I. The FS analysis found that a CDF at Terminal 4 is practicable as part of Alternatives E through I.

L9.1.2 Compliance with Water Quality Standards and ESA and Protection of Habitat (40 CFR Section 230.10(b))

Based on the evaluation of impacts in Section L3, the remedial alternatives have been assessed for their direct cause of or contribution to significant degradation of waters of the United States. Under 40 CFR 230.10(c), special emphasis on the persistence and permanence of the effects is considered in making the significant degradation determination. The potential risk of release of pollutants as part of the implementation of the remedial alternatives is generally low; the nature of the remedial action itself is to remove pollutants from the aquatic environment.

The potential to release pollutants arises from the removal of material via dredging and less so as part of the discharge of fill for capping, in-situ treatment, or ENR. In general, the release of pollutants via ongoing contributions of existing contaminants in the sediments poses a greater potential risk than undertaking a particular remedial alternative. The proposed alternatives evaluation indicates that implementation of capping or dredging technologies will not result in substantial water quality exceedances and therefore will not result in significant degradation. Based on this evaluation and the FS, proposed Alternatives B through I will meet all applicable state water quality standards within appropriate compliance distances and durations and are generally not expected to violate any toxic effluent standard or prohibition under CWA Section 307.

Release of pollutants may occur during in-water disposal of dredged material into a CDF; however, these activities are expected to be designed to meet EPA disposal performance standards such that discharges of return water meet water quality standards. The CDF would be designed and constructed to prevent release of contaminants and long-term impacts on water quality. Long-term monitoring will include evaluating physical stability of the CDF berm during and following high flow and flood events and groundwater quality monitoring of the CDF and berm.

The proposed remedial alternatives are likely to adversely affect listed species and designated critical habitat. Construction of the CDF would result in the loss of approximately 14 acres of aquatic habitat, and compensatory mitigation would be required, as described in Section L6. Activities would also comply with any additional terms and conditions imposed through site-specific reviews and consultation on potential impacts on listed species and critical habitat.

L9.1.3 Protections for Water Quality, Special Aquatic Sites (40 CFR Section 130.10(c))

These criteria involve prevention of significant degradation or significant adverse effects resulting from the discharge of pollutants on water supplies, fish and wildlife, aquatic organisms, and special aquatic sites; significant adverse effects on ecosystem diversity, productivity, or stability through the transfer of pollutants outside of the disposal site; and/or significant adverse effects on human use values (40 CFR 230.10(c)).

Alternatives B through I would result in minor impacts on wetlands, which would be mitigated. Research suggests that other special aquatic sites (mudflats, vegetated shallows, coral reefs, and riffle and pool complexes) are either unlikely or not present in the Site; this includes sanctuaries. Sanctuaries and wildlife management areas are located outside of the Site, and direct or indirect effects on these resources are not anticipated.

Negligible to minor but temporary effects are expected on recreational and commercial fisheries, water-related recreation, and aesthetics. Impacts to cultural resources cannot be fully defined until remedial design is completed; however, based upon initial research, it appears unlikely that cultural resources would be adversely affected by the alternatives.

The remedial alternatives would affect navigation and other water-dependent activities by displacing berthing space and partially blocking navigation access during construction, and interrupting maintenance dredging. The use of a CDF would reduce impacts on navigation by reducing the distance that barges would need to travel to transport dredged sediment for disposal. The removal of contaminated sediment should support better maintenance of navigation in the long term. In addition, the Terminal 4 CDF would create 17 acres for water-dependent commercial purposes.

L9.2 COMPLIANCE WITH PERTINENT LEGISLATION

Alternatives B through I are expected to comply with the Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands) and Oregon Environmental Cleanup Laws.

L10.0 FINDINGS

The proposed remedial alternatives are the least environmentally damaging practicable alternative that meets the project purpose and need. There are no practicable alternatives that avoid waters of the United States due to the location of the contaminated sediments.

The impacts of the proposed remedial alternatives are described in this document and each alternative has a different level of impacts. The more contaminated area the alternative actively addresses with dredging and capping the more short term impacts it has; but conversely, it has fewer long term impacts because it actively addresses more contamination. During remedial design, the specific acreages to be dredged and/or capped or otherwise filled will be determined and thus, the impacts to the aquatic environment may be reassessed and a supplemental 404(b)(1) evaluation may be needed. Based on current information, Table D2.n of Appendix D to the FS provides the acres assumed to require mitigation that were estimated for each alternative. It is important to note that for purposes of mitigation these estimates were based on shallow areas with traditional armoring, with shallow referring to depths of -13 feet NAVD88 or less. The estimates are as follows:

	Alternative							
	B	C	D	E	F	G	H	I
Sediment Areas With Armoring	13	16	23	33	58	84	172	32
Riverbank Areas with Armoring	2	2	2	2	2	2	2	2
Total Mitigation Area	15	18	25	35	60	86	174	34

In many areas, remediated shallow areas would be backfilled to existing elevations and/or beach mix would be used to provide appropriate substrate. This would minimize impacts on aquatic resources and reduce mitigation requirements. However, coordination with with NMFS and USFWS will be done during remedy design and implementation to identify any further mitigation requirements.

Disposal of dredged sediments would occur at upland locations or a combination of upland and CDF disposal. Construction and use of a CDF presents a viable option that may have some economic benefits, and may have less environmental impacts associated with transportation off-site. However, a CDF would result in unavoidable loss of approximately 14 acres of aquatic habitat that would require compensatory mitigation..

Avoidance and minimization measures and BMPs would be implemented throughout the remedial activities. In addition, avoidance and minimization measures would be implemented on site to restore substrate, slope, and natural cover to the extent possible to maintain habitats and functions that would be altered during implementation. Compensatory mitigation would be required to replace lost habitats and functions such that there would be “no net loss” of aquatic resource functions.

L11.0 REFERENCES

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Tables

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Table L3-1
ESA-Listed Species Evaluated in the Preliminary Biological Assessment
Portland Harbor Superfund Site
Portland, Oregon

NMFS Species	**Status**	**Critical Habitat Status**	**Presence in the Action Area**
Chinook salmon (*Oncorhynchus tshawytscha*)			
Upper Willamette River ESU	Threatened	Designated	LCR, LWR
Lower Columbia River ESU	Threatened	Designated	LCR, LWR
Upper Columbia River spring ESU	Endangered	Designated	LCR
Snake River spring/summer ESU	Threatened	Designated	LCR
Snake River fall ESU	Threatened	Designated	LCR
Chum salmon (*Oncorhynchus keta*), Columbia River ESU	Threatened	Designated	LCR
Coho salmon (*Oncorhynchus kisutch),* Lower Columbia River ESU	Threatened	Proposed	LCR, LWR
Sockeye salmon *(Oncorhynchus nerka),* Snake River Basin ESU	Endangered	Designated	LCR
Steelhead trout *(Oncorhynchus mykiss)*			
Upper Willamette River DPS	Threatened	Designated	LCR, LWR
Lower Columbia River DPS	Threatened	Designated	LCR, LWR
Upper Columbia River DPS	Endangered	Designated	LCR
Middle Columbia River DPS	Threatened	Designated	LCR
Snake River Basin DPS	Threatened	Designated	LCR
Eulachon (*Thaelichthys pacificus),* Southern DPS	Threatened	Designated	LCR
Green sturgeon (*Acipenser medirostris),* Southern DPS	Threatened	Designated	LCR
Killer Whale (*Orcinus orca*), Southern Resident DPS	Endangered	Designated, not within action area	LCR[1]
USFWS Species			
Bull trout *(Salvelinus confluentus)*	Threatened	Designated	LCR

Key:
NMFS = National Marine Fisheries Service
USFWS = U.S. Fish and Wildlife Service
ESU = Evolutionarily Significant Unit
DPS = Distinct Population Segment
LCR = Lower Columbia River
LWR = Lower Willamette River

Notes:
[1]Species does not occur in the LWR, but is included for potential effects to salmonid prey in the LCR.

Table L3-2

State Sensitive Species That May Occur within the Site or Its Vicinity

Portland Harbor Superfund Site

Portland, Oregon

Common Name	**Scientific Name**
Critical	
Burrowing owl	*Athene cunicularia*
Common nighthawk	*Chordeiles minor*
Foothill yellow-legged frog	*Rana boylii*
Gray wolf	*Canis lupus*
Lewis's woodpecker	*Melanerpes lewis*
Oregon spotted frog	*Rana pretiosa*
Oregon vesper sparrow	*Pooecetes gramineus affinis*
Pacific pond turtle	*Actinemys marmorata*
Painted turtle (only C. p. bellii SC)	*Chrysemys picta*
Purple martin	*Progne subis*
Streaked horned lark	*Eremophila alpestris strigata*
Townsend's big-eared bat	*Corynorhinus townsendii*
Western meadowlark	*Sturnella neglecta*
Western rattlesnake	*Crotalus oreganus*
Yellow-billed cuckoo	*Coccyzus americanus*
Yellow-breasted chat	*Icteria virens*
Vulnerable	
Acorn woodpecker	*Melanerpes formicivorus*
American peregrine falcon	*Falco peregrinus anatum*
Bald eagle	*Haliaeetus leucocephalus*
Black-tailed jack rabbit	*Lepus californicus*
Clouded salamander	*Aneides ferreus*
Hoary bat	*Lasiurus cinereus*
Little willow flycatcher	*Empidonax traillii brewsteri*
Long-legged myotis	*Myotis volans*
Northern goshawk	*Accipiter gentilis*
Northern red-legged frog	*Rana aurora*
Northern spotted owl	*Strix occidentalis caurina*
Olive-sided flycatcher	*Contopus cooperi*
Oregon slender salamander	*Batrachoseps wrighti*
Pallid bat	*Antrozous pallidus*
Silver-haired bat	*Lasionycteris noctivagans*
Western bluebird	*Sialia Mexicana*
Western gray squirrel	*Sciurus griseus*
Western toad	*Anaxyrus boreas*
White-breasted nuthatch	*Sitta carolinensis aculeate*

Source: ODFW (2008)

Figures

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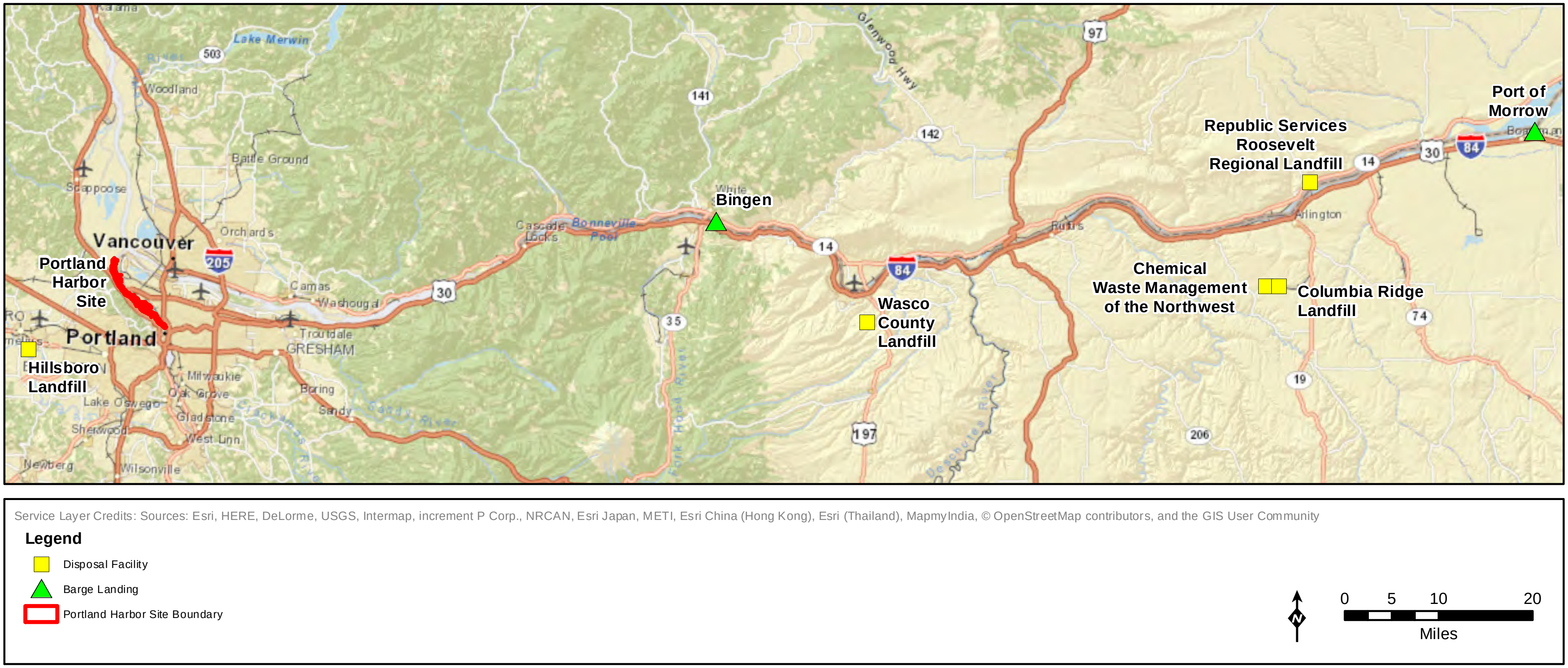

Figure L2-1. Potential Upland Disposal Facilities

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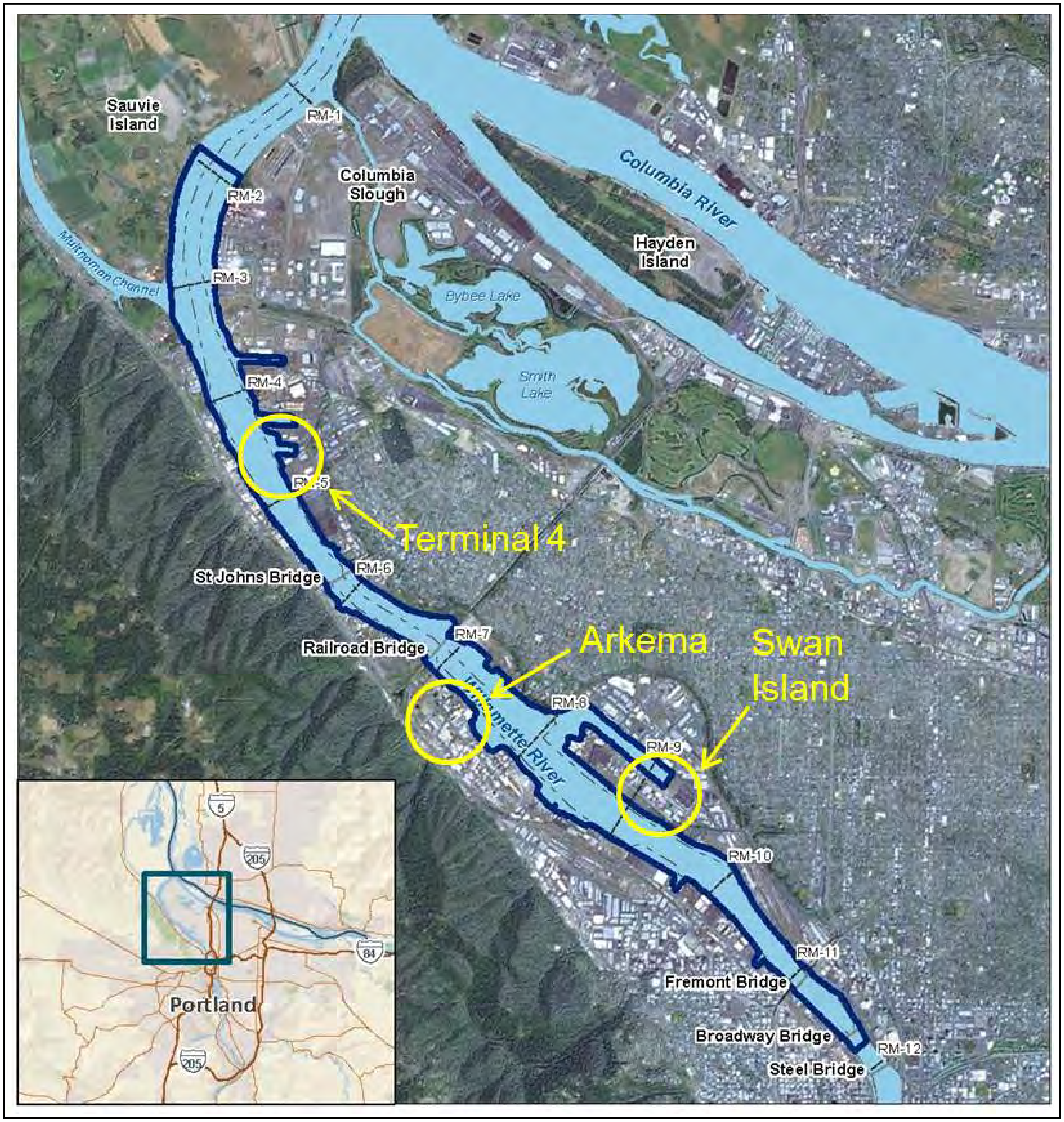

Figure L2-2. Potential CDF Sites

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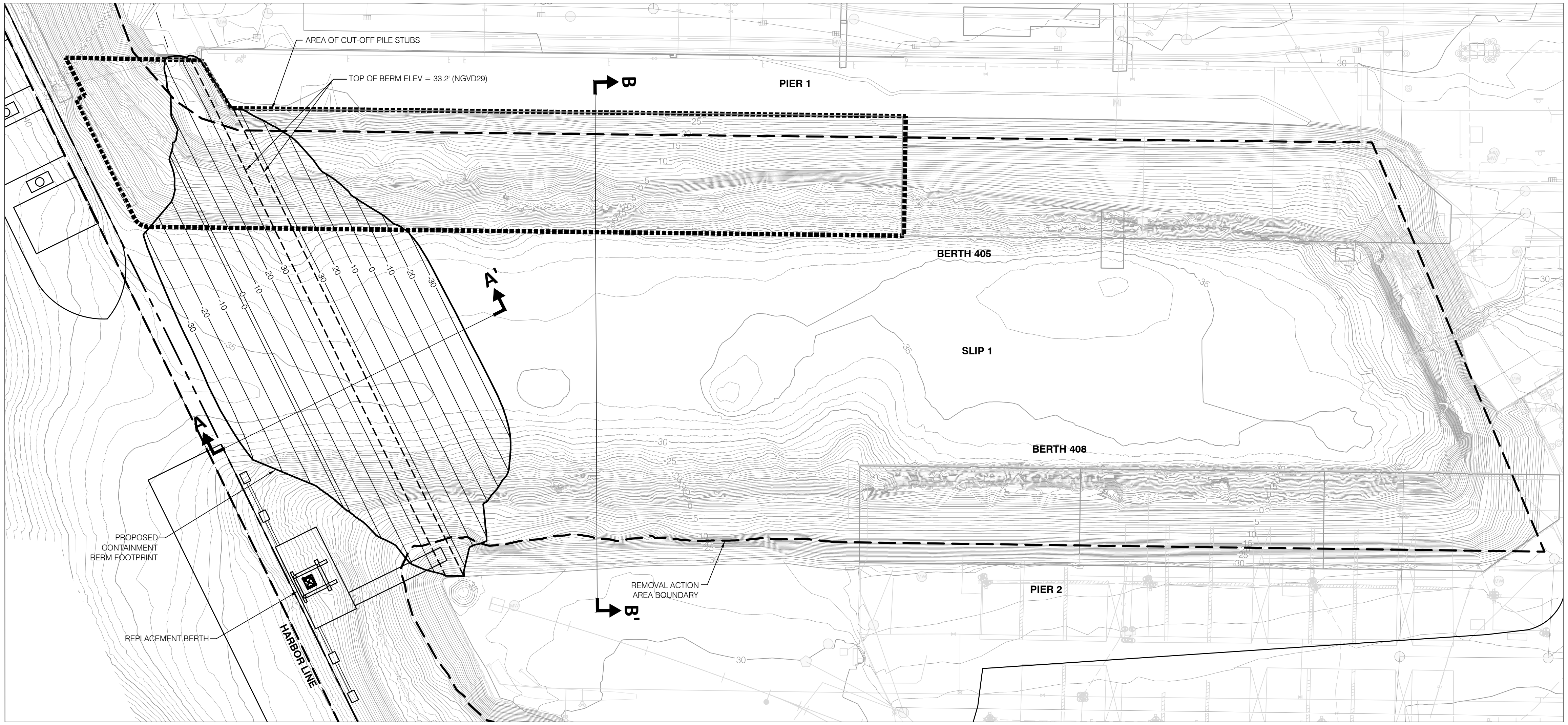
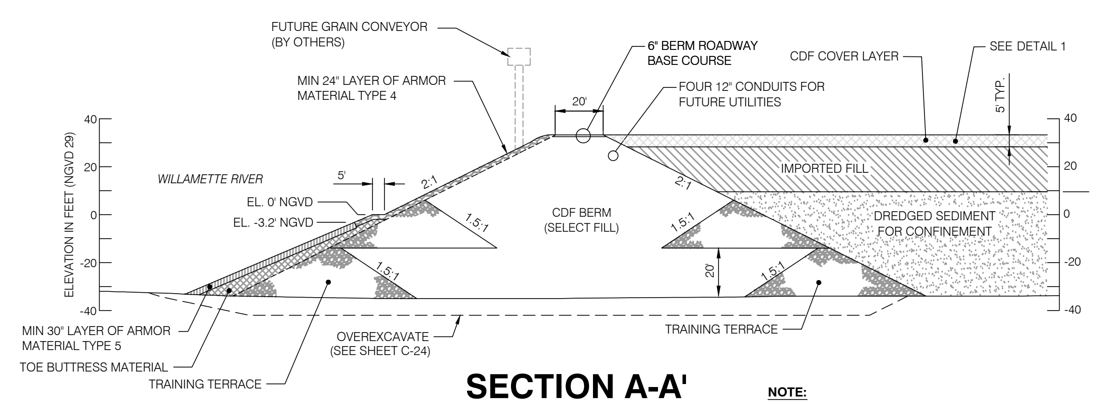


NOTES:

1. NGVD29 - National Geodetic Vertical Datum of 1929
   NAVD88 - North American Vertical Datum of 1988
2. HORIZONTAL DATUM: PORT OF PORTLAND LOCAL PROJECTION (INTERNATIONAL FEET)
   VERTICAL DATUM: NGVD 29-47
   CONTOUR INTERVAL = 1 FT
2. AT THIS LOCATION, THE CONVERSION FROM NGVD29 TO NAVD88 IS 3.4 FEET. THEREFORE, THE ELEVATION OF THE TOP OF THE CAP IS +33.2 FEET NGVD29 (+36.6 FEET NAVD88) AND THE MAXIMUM ELEVATION FOR THE PLACEMENT OF DREDGED SEDIMENT FOR CONFINEMENT IS +9.5 FEET NGVD29 (+12.9 FEET NAVD88).

0 160
Scale in Feet

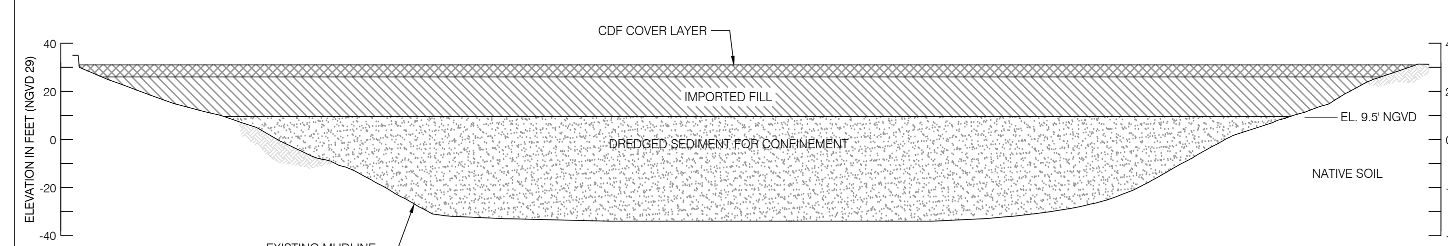


SECTION A-A'

0 80
Scale in Feet

NOTE:

CONTRACTOR CAN USE TRAINING TERRACES TO BUILD THE BERM. THE TERRACES SHALL EACH BE 20' IN HEIGHT. SEE SPECIFICATIONS FOR MORE DETAILS.



SECTION B-B'

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Scale in Feet

Figure L2-3. Terminal 4 CDF Concept Plan View

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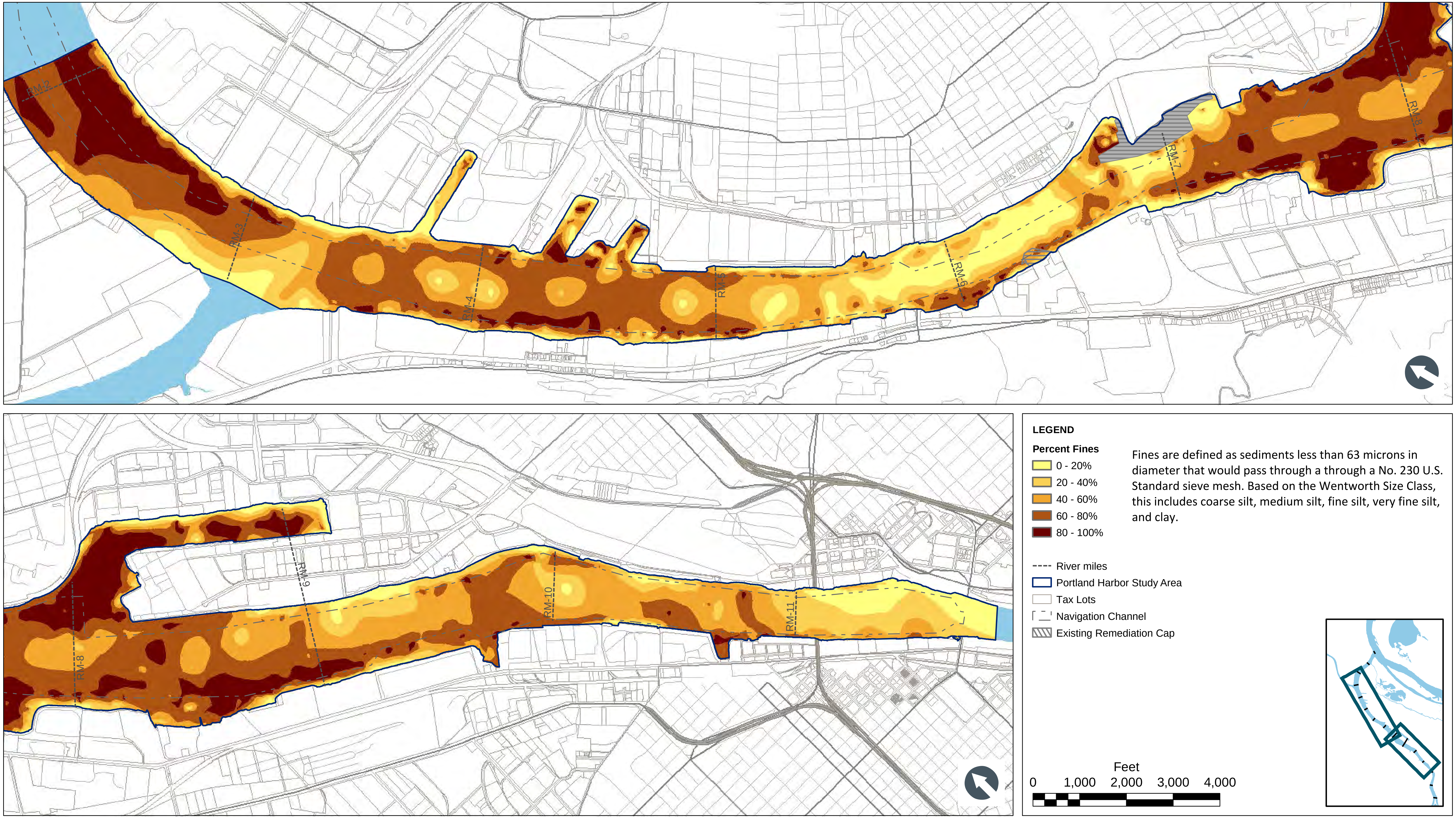

Figure L3-1. Existing Substrate Conditions

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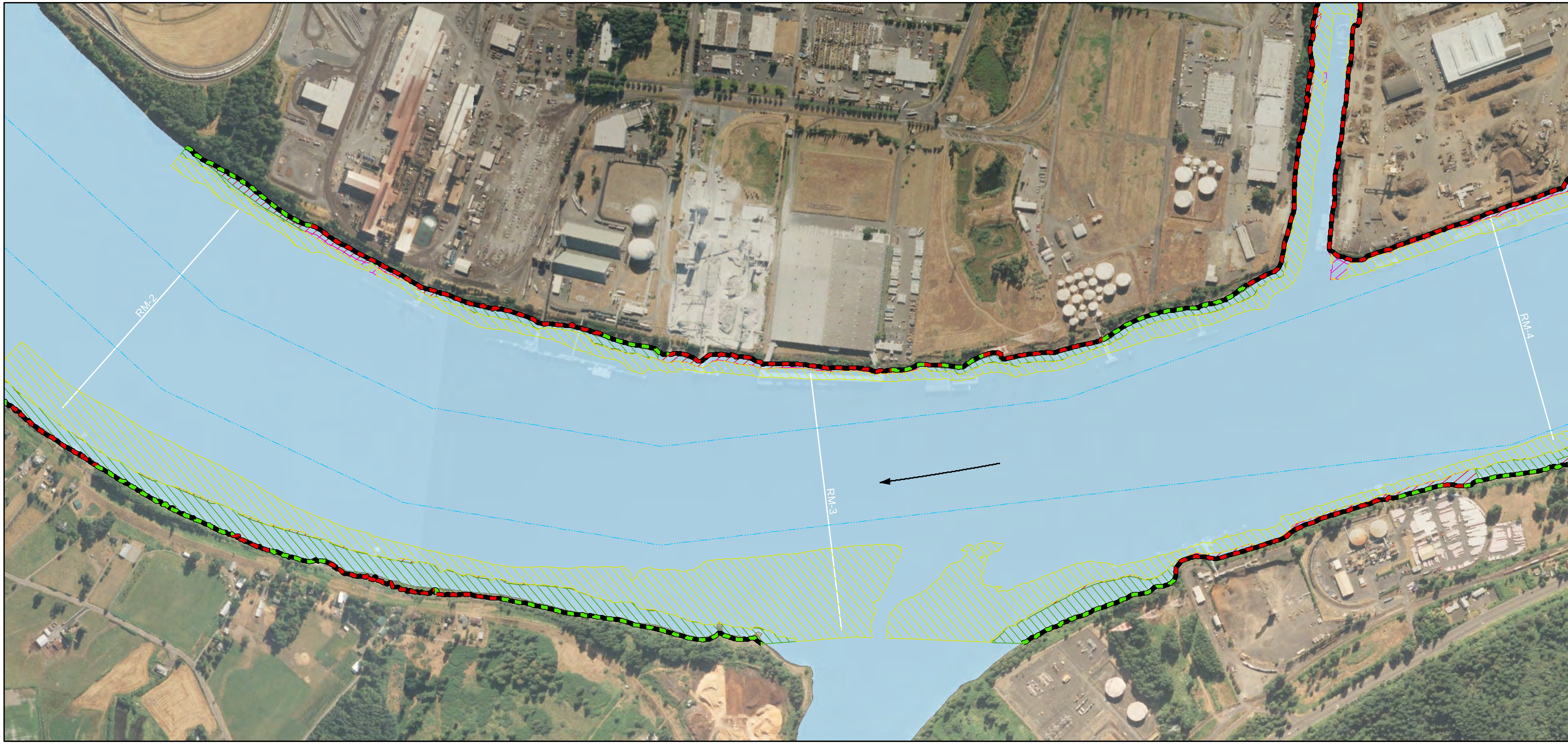

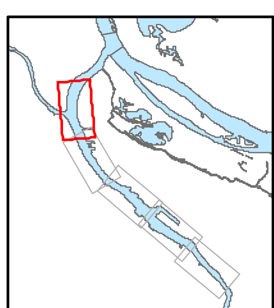

Presence of Natural Cover in Study Area
Absence of Natural Cover in Study Area
River Flow
Navigation Channel
Forage Presence in the Active Channel Margin
Forage Presence in the Shallow Water Zone
Forage Absence in the Active Channel Margin
Forage Absence in the Shallow Water Zone

NOTES:
Forage areas in the ACM are defined as unarmored beach (beach, bioengineered) as determined by the shoreline condition dataset. Forage areas in shallow water are defined as 20 feet below ordinary low water with small substrate size (< 64 mm; no debris covering the substrate).
Natural cover is defined as a riparian area with mature trees/shrubs with woody stems that overhand the ACM and large woody debris accumulations as determined from photo-interpretation of 2005 aerial photographs.

0 500 1,000
Feet

Figure L3-2a. Shallow Water Forage Areas: Rivermile 1.9 to 4

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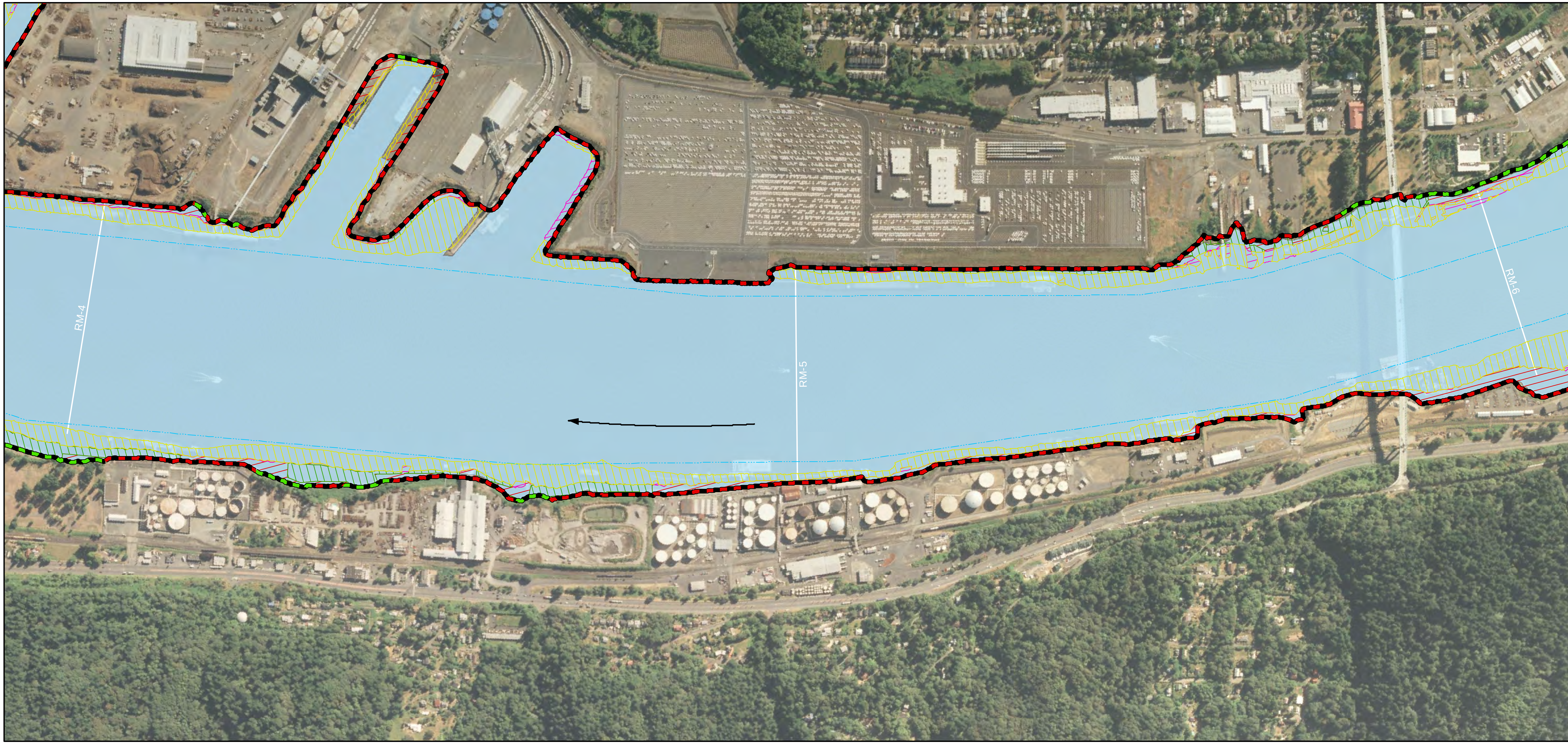

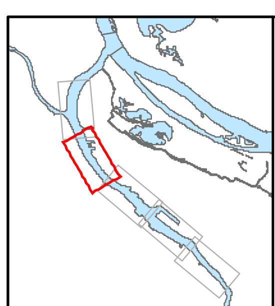

- Presence of Natural Cover in Study Area
- Absence of Natural Cover in Study Area
- River Flow
- Navigation Channel
- Forage Presence in the Active Channel Margin
- Forage Presence in the Shallow Water Zone
- Forage Absence in the Active Channel Margin
- Forage Absence in the Shallow Water Zone

NOTES:

Forage areas in the ACM are defined as unarmored beach (beach, bioengineered) as determined by the shoreline condition dataset. Forage areas in shallow water are defined as 20 feet below ordinary low water with small substrate size (< 64 mm; no debris covering the substrate).
Natural cover is defined as a riparian area with mature trees/shrubs with woody stems that overhand the ACM and large woody debris accumulations as determined from photo-interpretation of 2005 aerial photographs.

0 500 1,000
Feet

Figure L3-2b. Shallow Water Forage Areas: Rivermile 4 to 6

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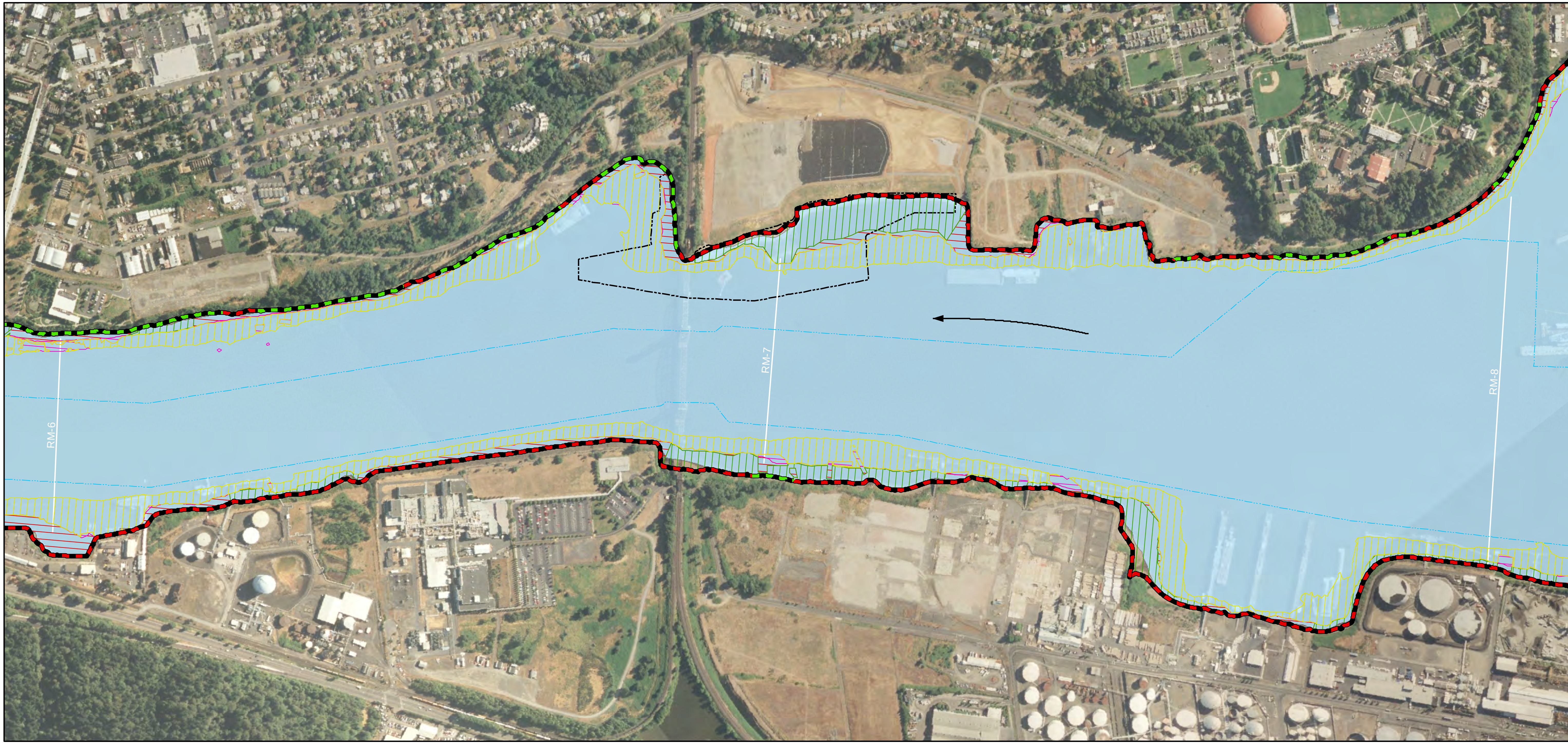
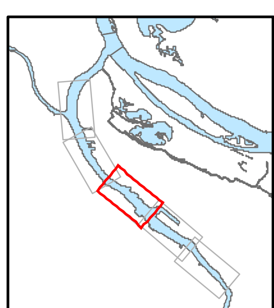


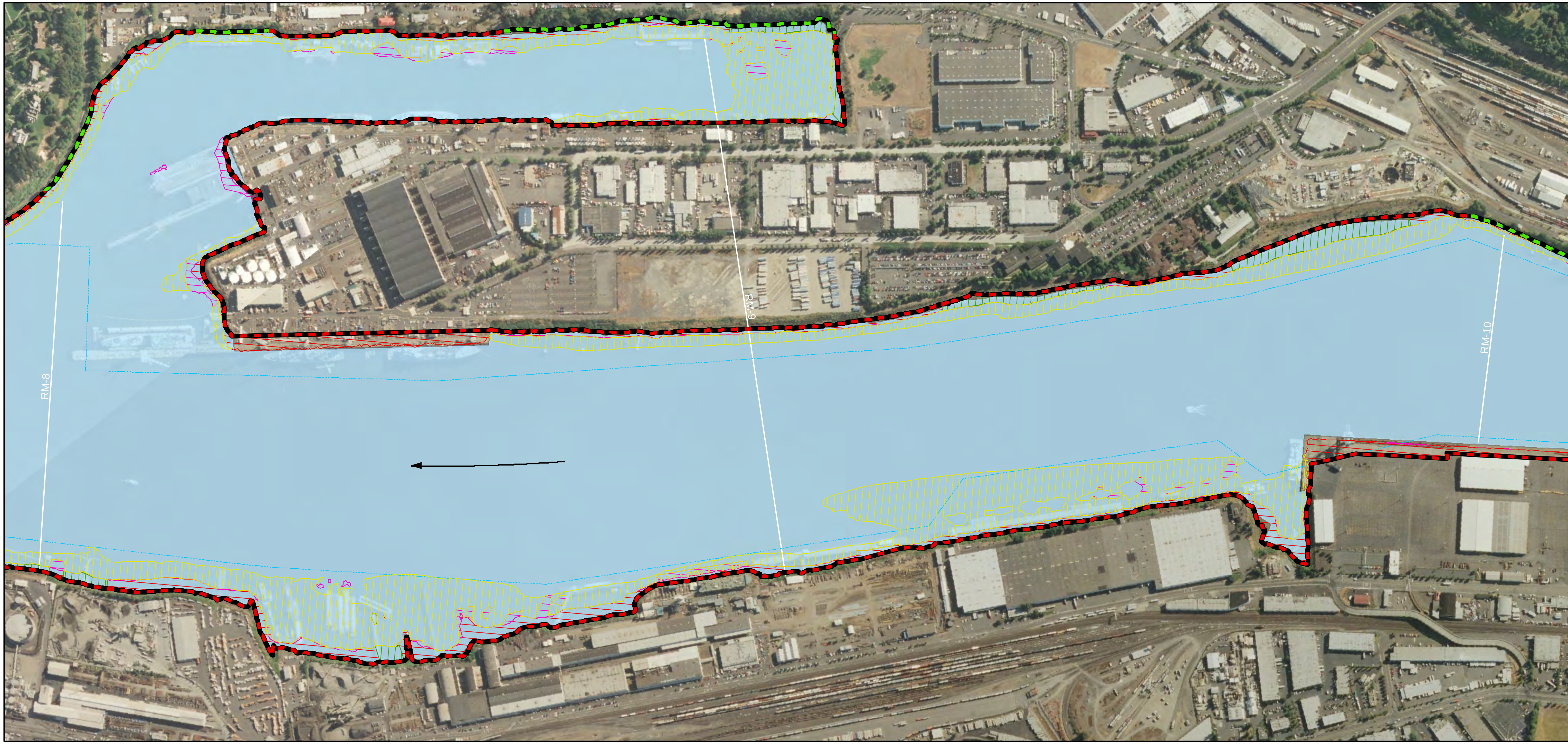


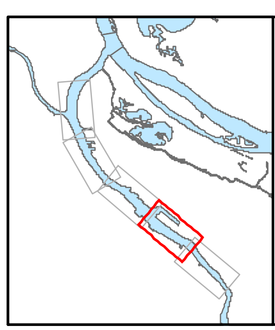
Presence of Natural Cover in Study Area
Absence of Natural Cover in Study Area
River Flow
Navigation Channel
Forage Presence in the Active Channel Margin
Forage Presence in the Shallow Water Zone
Forage Absence in the Active Channel Margin
Forage Absence in the Shallow Water Zone

NOTES:
Forage areas in the ACM are defined as unarmored beach (beach, bioengineered) as determined by the shoreline condition dataset. Forage areas in shallow water are defined as 20 feet below ordinary low water with small substrate size (< 64 mm; no debris covering the substrate).
Natural cover is defined as a riparian area with mature trees/shrubs with woody stems that overhand the ACM and large woody debris accumulations as determined from photo-interpretation of 2005 aerial photographs.

0 500 1,000
Feet

Figure L3-2c. Shallow Water Forage Areas: Rivermile 6 to 8





Presence of Natural Cover in Study Area
Absence of Natural Cover in Study Area
River Flow
Navigation Channel
Forage Presence in the Active Channel Margin
Forage Presence in the Shallow Water Zone
Forage Absence in the Active Channel Margin
Forage Absence in the Shallow Water Zone

NOTES:
Forage areas in the ACM are defined as unarmored beach (beach, bioengineered) as determined by the shoreline condition dataset. Forage areas in shallow water are defined as 20 feet below ordinary low water with small substrate size (< 64 mm; no debris covering the substrate).
Natural cover is defined as a riparian area with mature trees/shrubs with woody stems that overhand the ACM and large woody debris accumulations as determined from photo-interpretation of 2005 aerial photographs.

0 500 1,000
Feet

Figure L3-2d. Shallow Water Forage Areas: Rivermile 8 to 10

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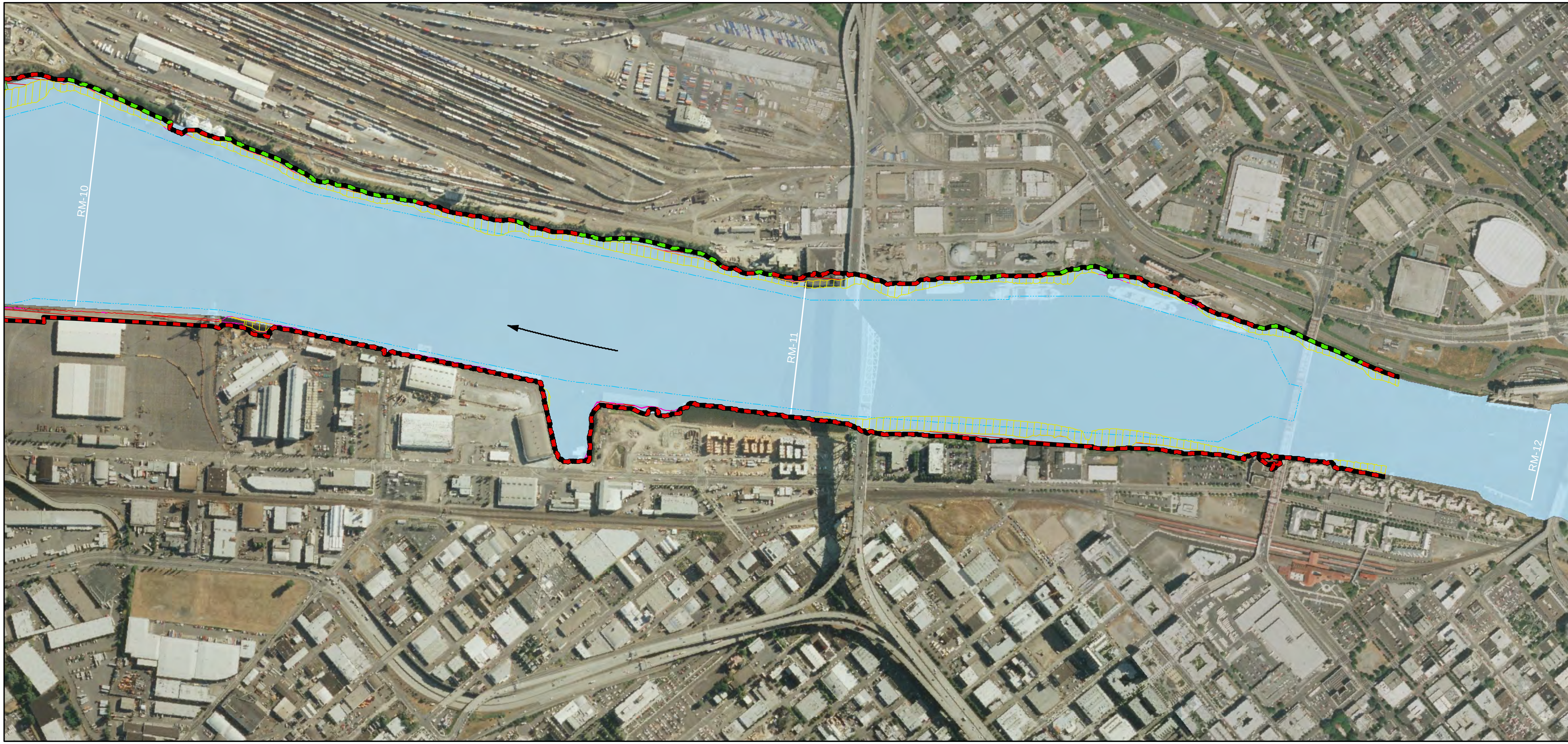

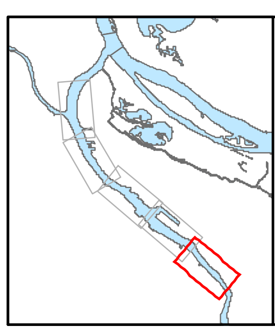

- Presence of Natural Cover in Study Area
- Absence of Natural Cover in Study Area
- River Flow
- Navigation Channel
- Forage Presence in the Active Channel Margin
- Forage Presence in the Shallow Water Zone
- Forage Absence in the Active Channel Margin
- Forage Absence in the Shallow Water Zone

NOTES:

Forage areas in the ACM are defined as unarmored beach (beach, bioengineered) as determined by the shoreline condition dataset. Forage areas in shallow water are defined as 20 feet below ordinary low water with small substrate size (< 64 mm; no debris covering the substrate).
Natural cover is defined as a riparian area with mature trees/shrubs with woody stems that overhand the ACM and large woody debris accumulations as determined from photo-interpretation of 2005 aerial photographs.

Figure L3-2e. Shallow Water Forage Areas: Rivermile 10 to 12

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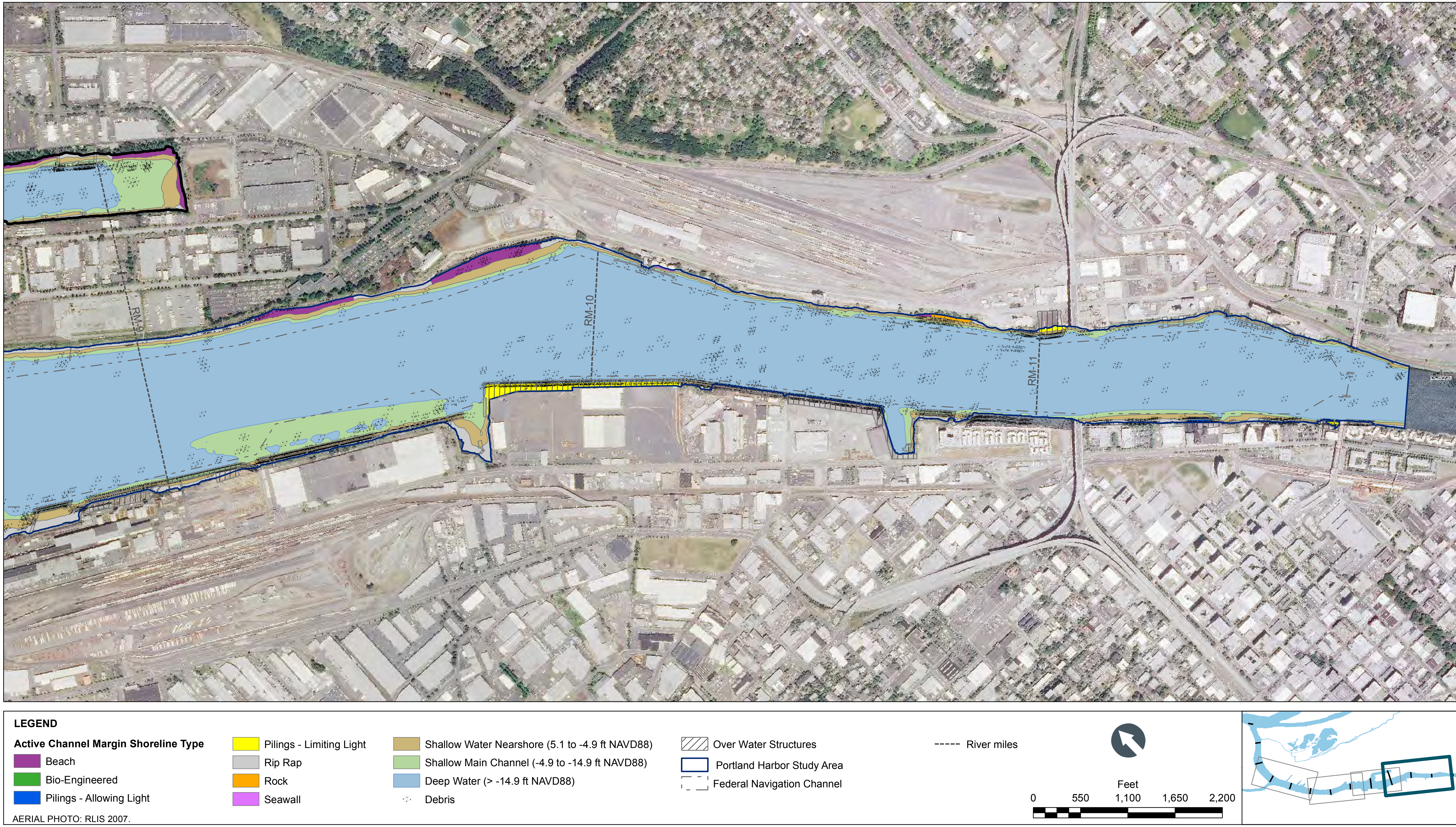

Figure L3-3a. Existing Shoreline and Water Depth Locations

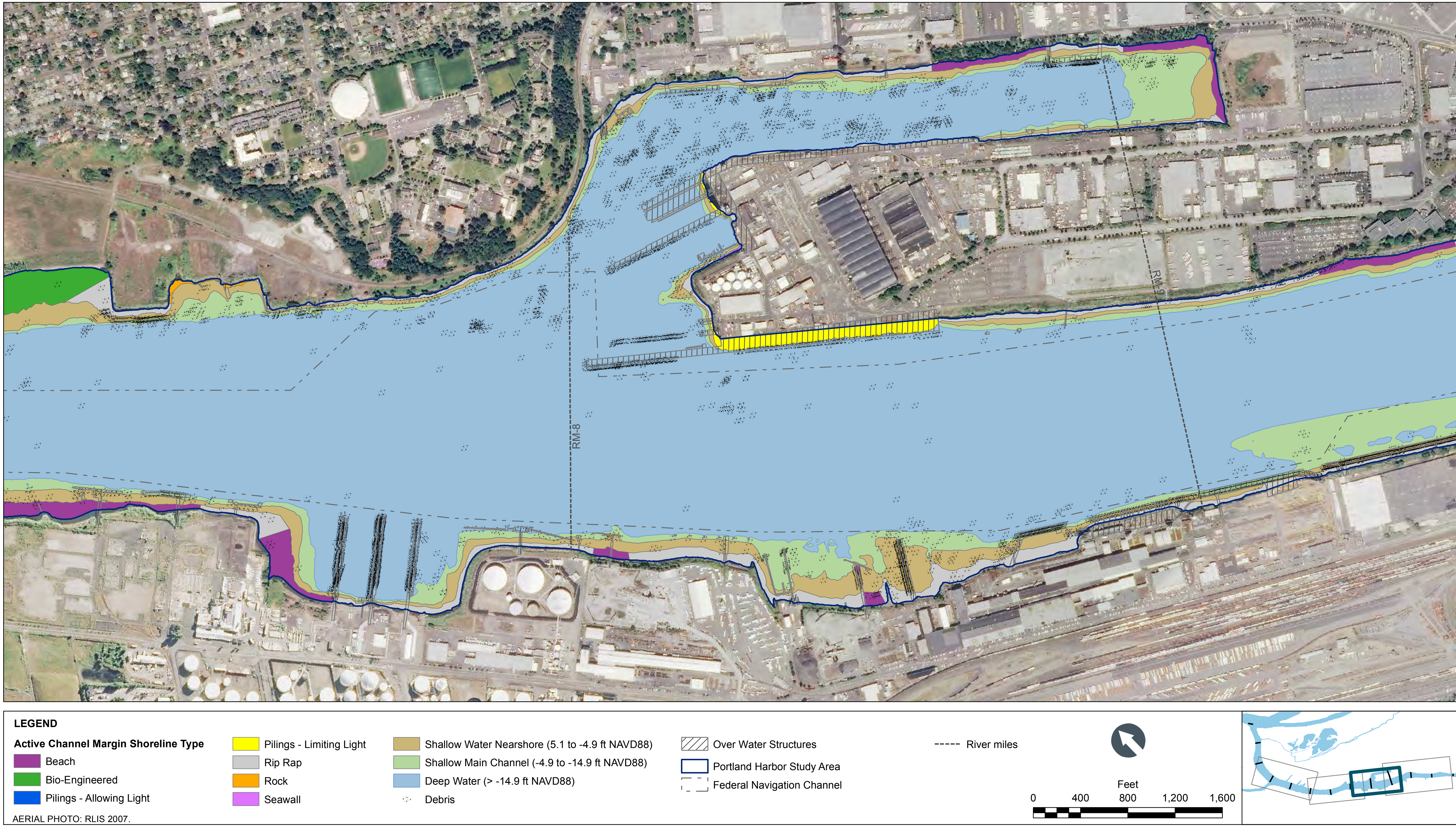

Figure L3-3b. Existing Shoreline and Water Depth Locations

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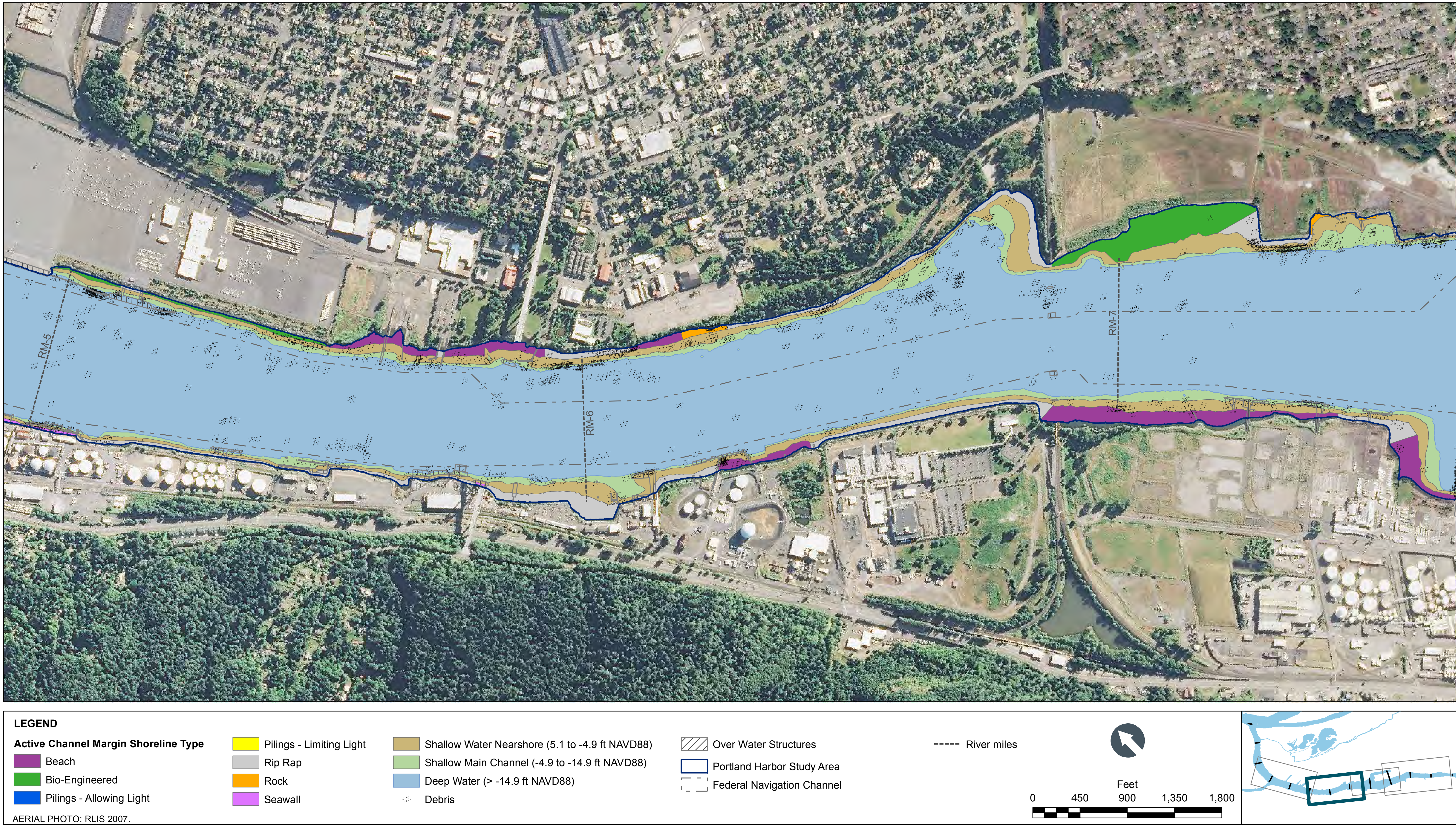

Figure L3-3c. Existing Shoreline and Water Depth Locations

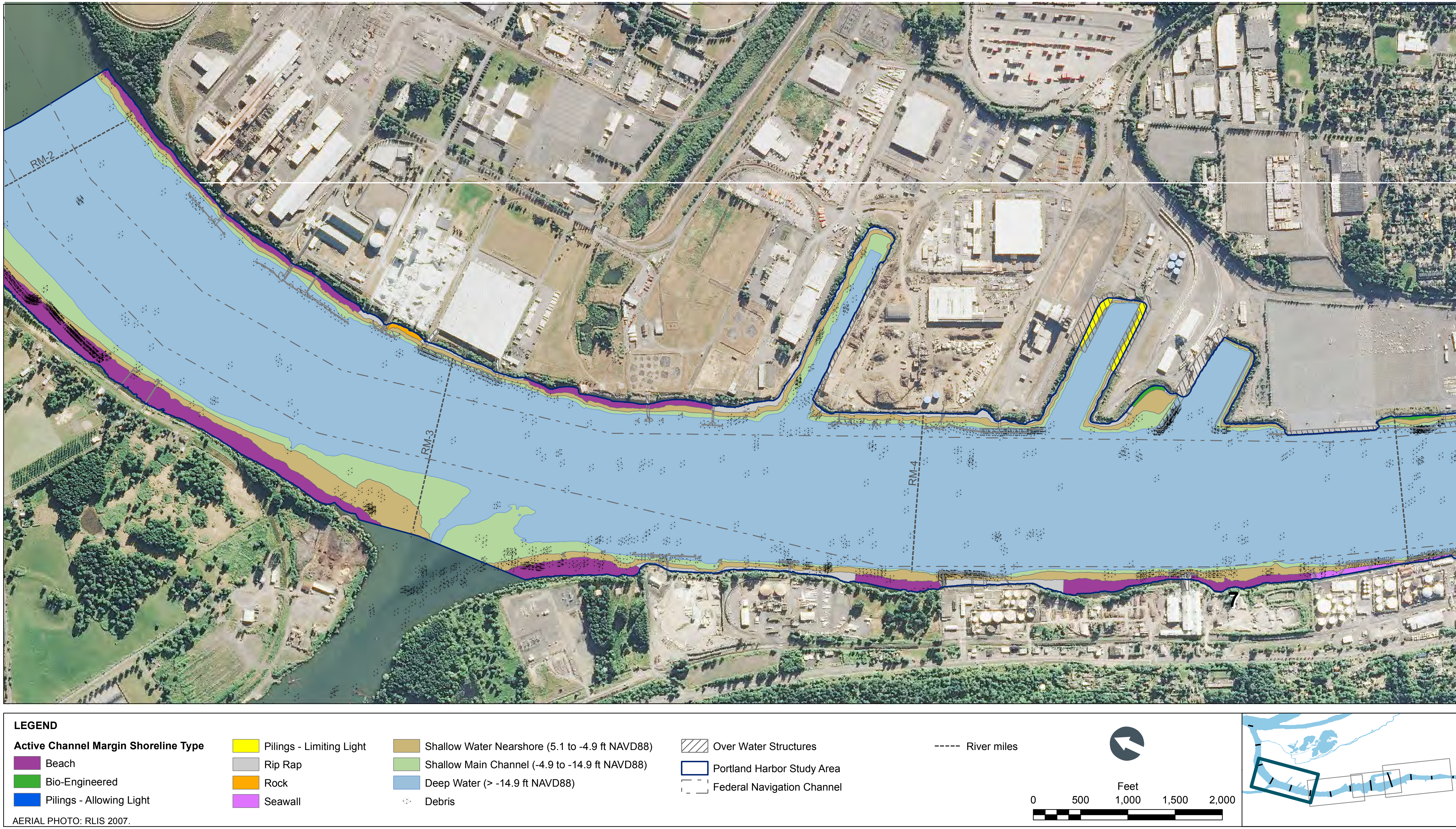

Figure L3-3d. Existing Shoreline and Water Depth Locations

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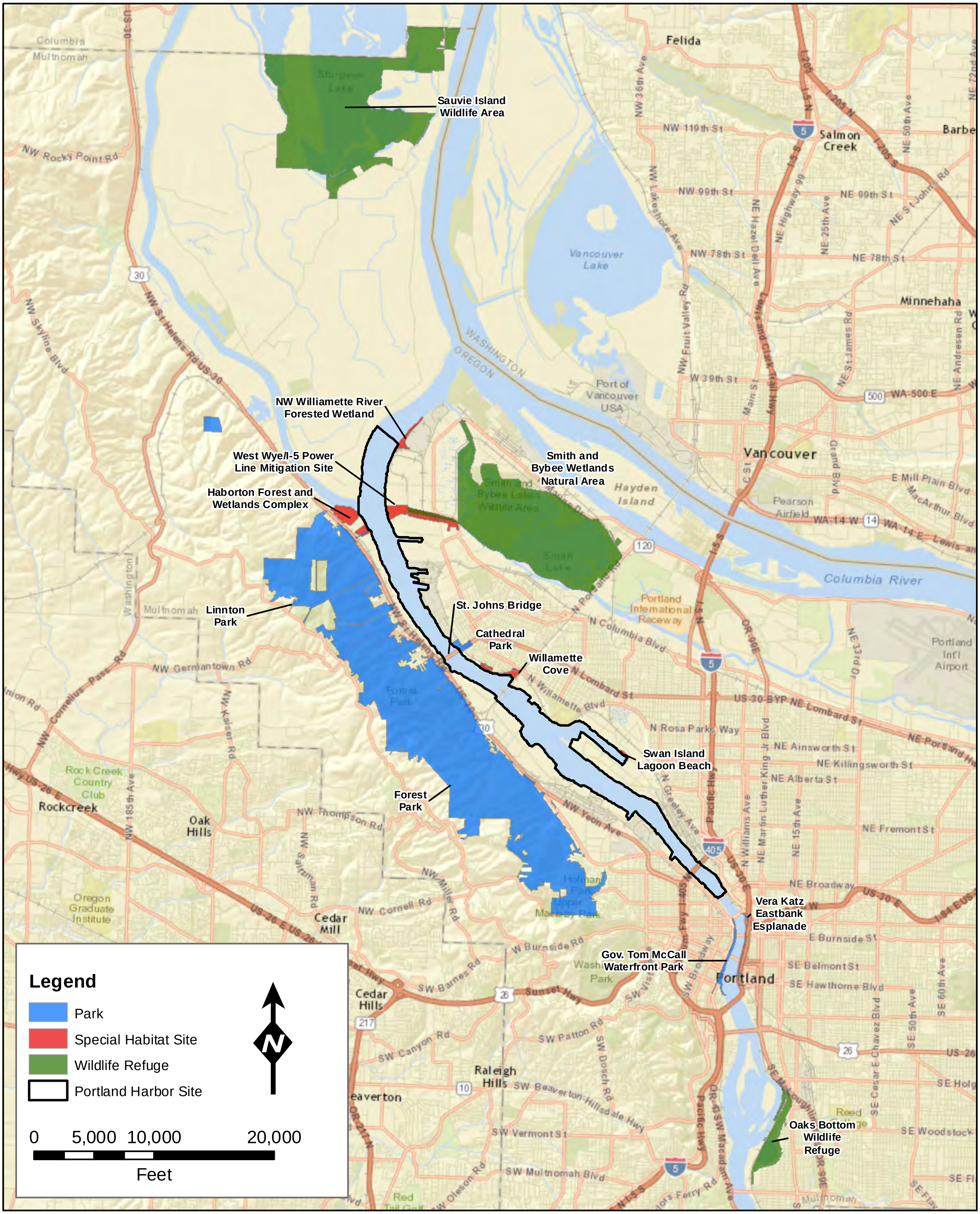

Source Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure L3-4. Parks, Wildlife Refuges, and Habitat Areas

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Date: 3/23/2016

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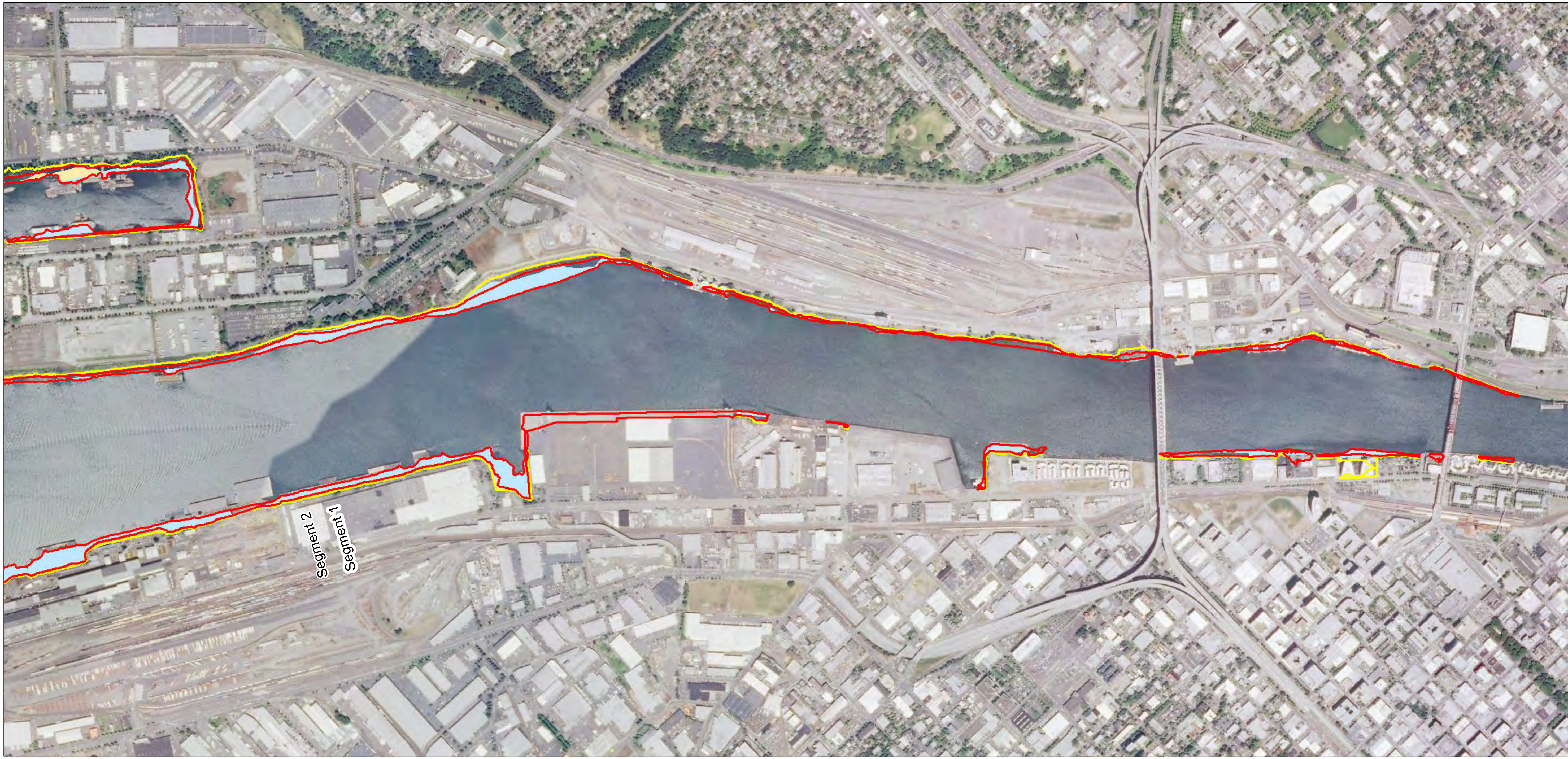

LEGEND

- Project Area: OHW (13 ft NAVD88) to OLW (5.1 ft NAVD88)
- Up to 20.1 ft NAVD88
- PEMR: Palustrine, emergent, seasonal
- PSSR: Palustrine, scrub-shrub, seasonal
- R1UBV: Riverine, unconsolidated bottom, permanent tidal
- R1USN: Riverine, unconsolidated shore, regularly flooded
- R1USR: Riverine, unconsolidated shore, seasonal
- R3UBH: Riverine Upper Perennial, unconsolidated bottom, permanently flooded
- R4SBC: Riverine Intermittent, streambed, seasonally flooded

NOTES:
1. Data: Oregon Wetlands Cover (October 30, 2009)
2. Aerial Photo: NAIP 2011.

Feet
0 550 1,100 1,650 2,200

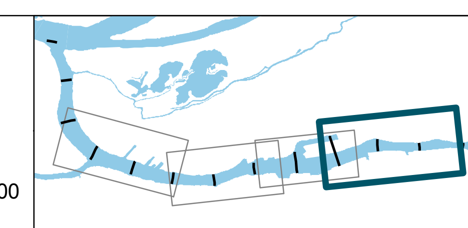

Figure L3-5a. Wetlands Identified in the Study Area

LEGEND

- Project Area: OHW (13 ft NAVD88) to OLW (5.1 ft NAVD88)
- Up to 20.1 ft NAVD88
- PEMR: Palustrine, emergent, seasonal
- PSSR: Palustrine, scrub-shrub, seasonal
- R1UBV: Riverine, unconsolidated bottom, permanent tidal
- R1USN: Riverine, unconsolidated shore, regularly flooded
- R1USR: Riverine, unconsolidated shore, seasonal
- R3UBH: Riverine Upper Perennial, unconsolidated bottom, permanently flooded
- R4SBC: Riverine Intermittent, streambed, seasonally flooded

NOTES:
1. Data: Oregon Wetlands Cover (October 30, 2009)
2. Aerial Photo: NAIP 2011.

Feet

0 400 800 1,200 1,600

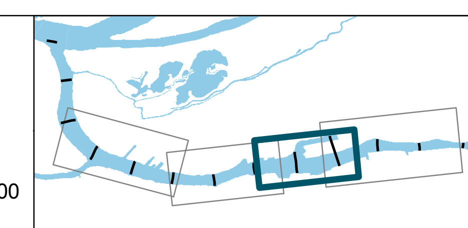

Figure L3-5b. Wetlands Identified in the Study Area

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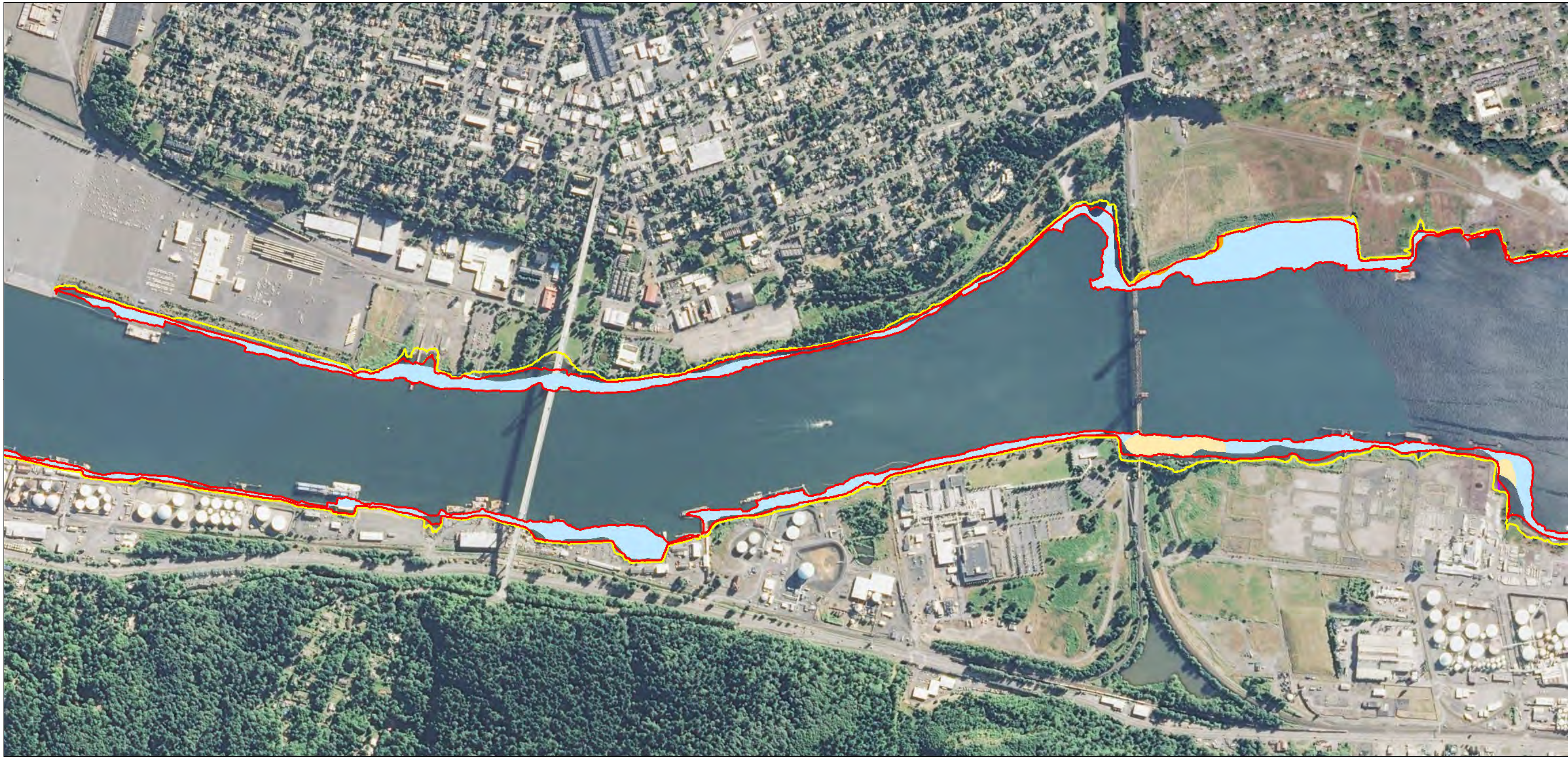

LEGEND

- Project Area: OHW (13 ft NAVD88) to OLW (5.1 ft NAVD88)
- Up to 20.1 ft NAVD88
- PEMR: Palustrine, emergent, seasonal
- PSSR: Palustrine, scrub-shrub, seasonal
- R1UBV: Riverine, unconsolidated bottom, permanent tidal
- R1USN: Riverine, unconsolidated shore, regularly flooded
- R1USR: Riverine, unconsolidated shore, seasonal
- R3UBH: Riverine Upper Perennial, unconsolidated bottom, permanently flooded
- R4SBC: Riverine Intermittent, streambed, seasonally flooded

NOTES:
1. Data: Oregon Wetlands Cover (October 30, 2009)
2. Aerial Photo: NAIP 2011.

Feet

0 450 900 1,350 1,800

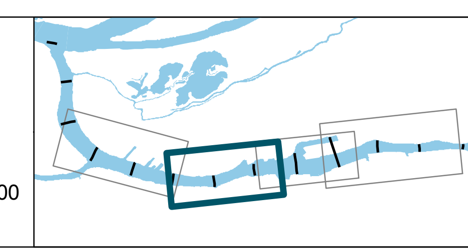

Figure L3-5c. Wetlands Identified in the Study Area

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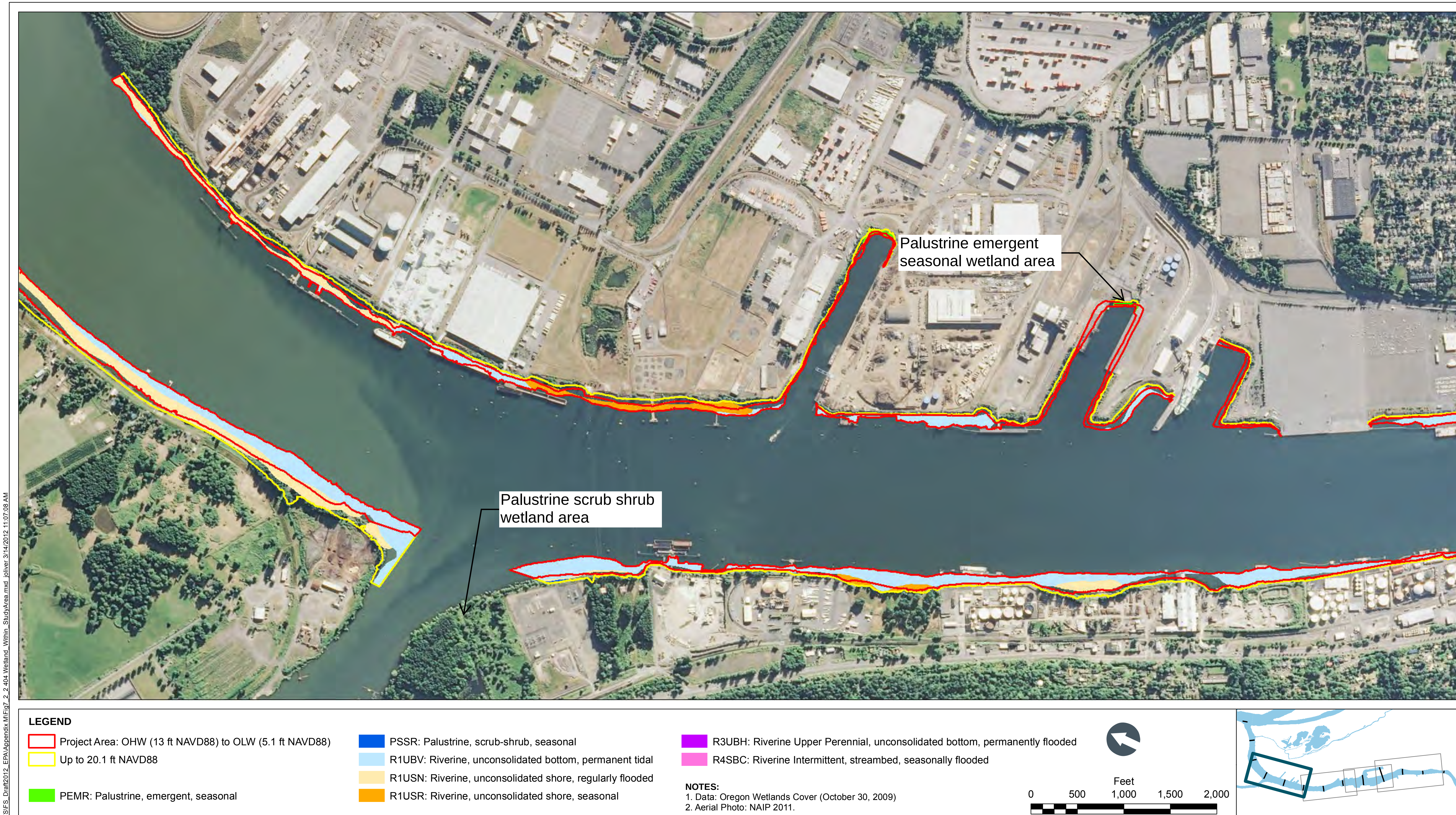
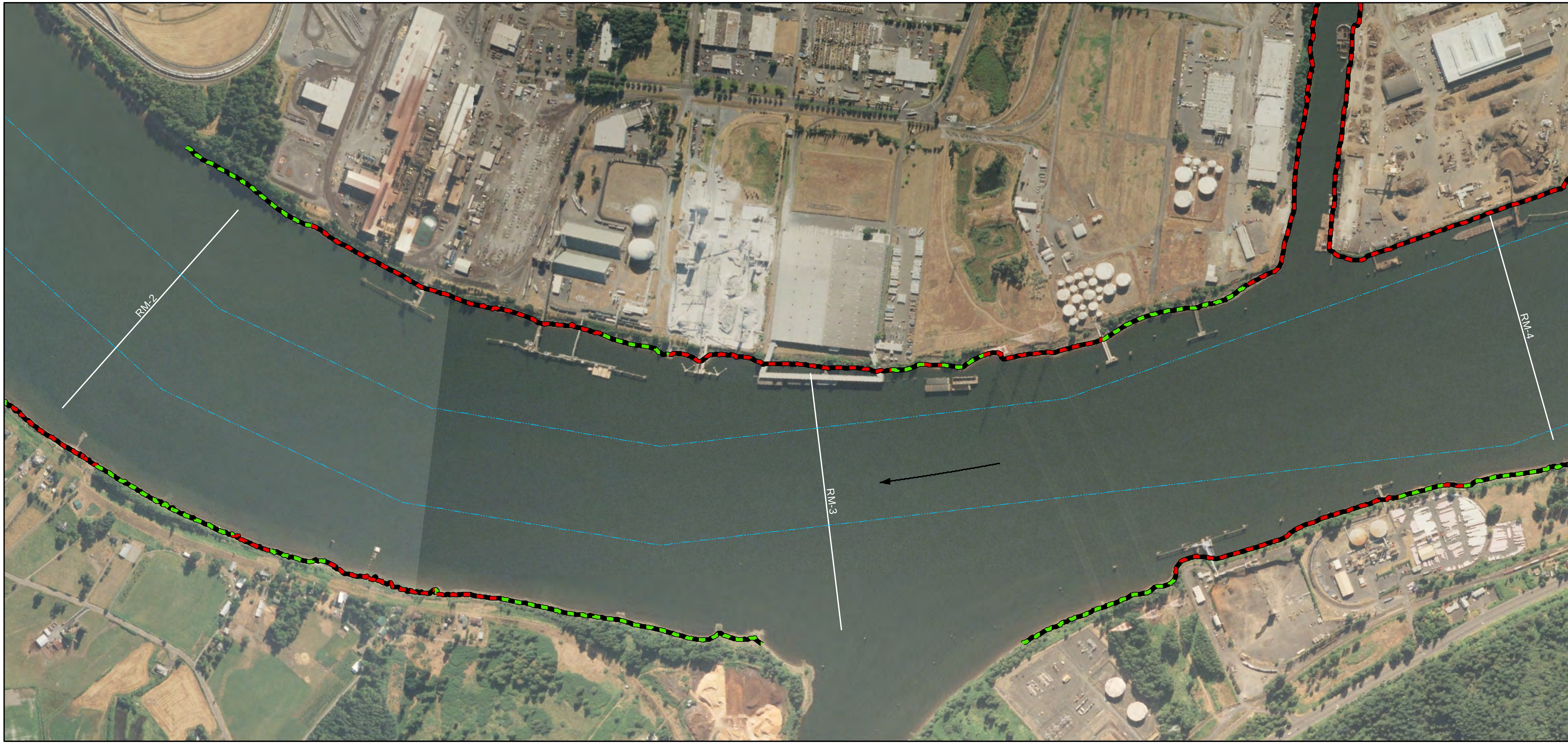
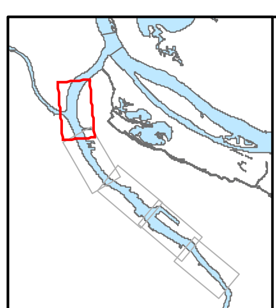


Figure L3-5d. Wetlands Identified in the Study Area





Presence of Natural Cover in Study Area

Absence of Natural Cover in Study Area

River Flow

Navigation Channel

NOTES:

Natural cover is defined as a riparian area with mature trees/shrubs with woody stems that overhand the ACM and large woody debris accumulations as determined from photo-interpretation of 2005 aerial photographs.

0 500 1,000

Feet

Figure L3-6a. Presence of Natural Cover: Rivermile 1.9 to 4

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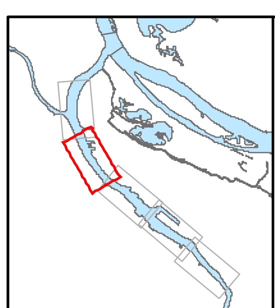

Presence of Natural Cover in Study Area

Absence of Natural Cover in Study Area

River Flow

Navigation Channel

NOTES:

Natural cover is defined as a riparian area with mature trees/shrubs with woody stems that overhand the ACM and large woody debris accumulations as determined from photo-interpretation of 2005 aerial photographs.

0 500 1,000

Feet

Figure L3-6b. Presence of Natural Cover: Rivermile 4 to 6

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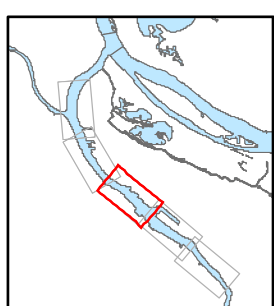


Presence of Natural Cover in Study Area

Absence of Natural Cover in Study Area

River Flow

Navigation Channel

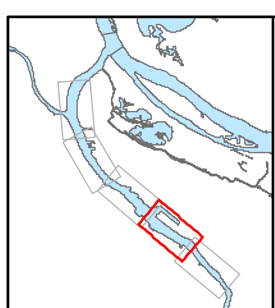
NOTES:

Natural cover is defined as a riparian area with mature trees/shrubs with woody stems that overhand the ACM and large woody debris accumulations as determined from photo-interpretation of 2005 aerial photographs.

0 500 1,000

Feet

Figure L3-6c. Presence of Natural Cover: Rivermile 6 to 8



Presence of Natural Cover in Study Area

Absence of Natural Cover in Study Area

River Flow

Navigation Channel

NOTES:

Natural cover is defined as a riparian area with mature trees/shrubs with woody stems that overhand the ACM and large woody debris accumulations as determined from photo-interpretation of 2005 aerial photographs.

0 500 1,000

Feet

Figure L3-6d. Presence of Natural Cover: Rivermile 8 to 10

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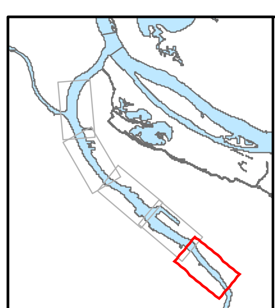

Presence of Natural Cover in Study Area

Absence of Natural Cover in Study Area

River Flow

Navigation Channel

NOTES:
Natural cover is defined as a riparian area with mature trees/shrubs with woody stems that overhand the ACM and large woody debris accumulations as determined from photo-interpretation of 2005 aerial photographs.

0 500 1,000
Feet

Figure L3-6e. Presence of Natural Cover: Rivermile 10 to 12